Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

SEPTEMBER, 1915.

GREAT ASTRONOMERS.

By W. F. DENNING, F.R.A.S.

PROFESSOR WILLIAM R. BROOKS (see Figure 228) has been the most successful of all modern comet-finders. No fewer than twenty-seven of these wonderful bodies have been discovered by him since 1881 as a result of his unwearying effort and acute vision.

He is an Englishman by birth, though his astronomical work has been performed in America. Born at Maidstone, in Kent, on June 11th, 1844, he went to America with his parents in 1857. Naturally very fond of astronomy, he made himself a reflecting telescope, and started comet-seeking about thirty-five years ago. He soon achieved marked success, and rediscovered Pons's and Olbers's Comets at their returns in 1884 and 1887. In 1889 he picked up a very interesting periodical comet, which in the vear named divided into several portions.

Mr. Brooks was appointed Professor of Astronomy at Hobart and William Smith Colleges, and carries on his comet-seeking at Geneva, New York, with a twelve-inch refractor.

Professor E. E. Barnard (see Figure 229), born in 1857 at Nashville, Tennessee, has such a lengthy record of observational discoveries and successes that it would be difficult to enumerate them all. Starting his astronomical career as an amateur with a five-inch refractor, his initial work consisted in observing the surface markings on Jupiter and in sweeping for comets. Of the latter objects he discovered no fewer than twenty during the years 1881 to 1892.

His special abilities led to his being appointed one of the astronomers at the Lick Observatory on Mount Hamilton, and he soon distinguished himself there by detecting the fifth satellite of Jupiter. This was effected with the thirty-six-inch refractor, and the feat formed a significant tribute to the quality of the instrument, as well as to the keen observational powers of the discoverer.

Mr. Barnard also obtained a series of valuable micrometric measures of the planets, and determined their real diameters. The degree of accuracy attained was very great, and the results highly valuable, especially in regard to the minor planets, Ceres, Pallas, Juno, and Vesta. He proved that Vesta was much smaller than Ceres and Pallas, though of much greater apparent brightness.

Mr. Barnard's photographic work has also been of high class and very abundant character. His pictures of various comets, and notably Morehouse's in 1908, have shown the remarkable irregularities and rapid variations displayed in the tails of these wonderful bodies.

In later years Mr. Barnard has worked at the Yerkes Observatory at Chicago, where he has the advantage of using the forty-inch refractor. He has continued his important labours there, and numerous papers from his pen have appeared in the *Astron. Jour.*, *Astron. Nach.*, and other publications. Mr. Barnard has had the use of the best telescopes of his day, and he has proved himself the most successful observer.

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The gold medal of the Royal Astronomical Society was awarded to him in 1897.

Professor Alexander Stewart Herschel (see Figure 230) was born in 1836, and was the second son of Sir John F. W. Herschel. Like his father and grandfather, he had a great love for astronomy, and for more than forty-five years made numerous observations, and contributed many articles to scientific journals on the subject of shooting stars.

In 1871 he was appointed Professor of Physics at the Durham College of Science, Newcastle-on-Tyne, and retained the post for fifteen years. He wrote the valuable reports on Luminous Meteors for the British Association for the Advancement of Science between 1861 and 1881.

There is no doubt that during nearly half a century Professor Herschel accomplished a vast amount of useful work in the field of meteoric astronomy.

In 1866 he observed the great Leonid shower, and collected the various determinations of the radiant point. In 1872 he called attention to the probable occurrence of a rich shower of Andromedids connected with Biela's Comet, and his prediction was amply verified on November 27th of that year. In 1874 he gave a list of the computed radiant points and dates of comets. In conjunction with Mr. R. P. Greg, he published several catalogues of radiant points of meteoric showers, and calculated the real paths of many fireballs and ordinary shooting stars.

His work was sound, accurate, and very painstaking. He encouraged others to study the attractive features of meteoric astronomy. A most prolific writer and entertaining correspondent, his letters on the subject of meteors were of the highest degree of interest. His work will be revered, not only because the name of Herschel was made illustrious by his ancestors, but because he himself achieved so much success as one of the pioneers of meteoric astronomy. He died on June 18th, 1907.

Professor Herschel was the first to discover the accordance between the orbits of Halley's Comet and of a rich meteoric shower from Aquarius, observed by Lieut.-Col. Tupman in 1869–71, at the end of April and opening of May.

Professor S. W. Burnham (see Figure 231) began his astronomy as an amateur; and, with only a six-inch telescope, soon made himself famous as an observer and discoverer of double stars. His abilities in this field were, in fact, so pronounced that he was appointed astronomer at the Lick Observatory, and afterwards became attached to the Yerkes Observatory at Chicago. Just as Barnard has, in a measure, emulated the valuable labours of Sir W. Herschel, and Brooks has reiterated the cometary discoveries of Pons, so has Burnham supplemented the splendid work of Wilhelm Struve in the realm of double stars.

Mr. Burnham possessed, not only the inclination, but also the special ability required for this class of observation. These, in combination with untiring energy and the most powerful of modern telescopes, have enabled him to achieve marvellous success in a sphere of work where one would have supposed that not many prizes remained to be won. But the sidereal heavens are of inexhaustible vastness, and so, after all Herschel's sweeping and the lives of prolific effort spent by the Struves, by South, Dawes, and a host of other double-star observers, there still remained ample gleaning to be effected by the keen eye and steadfast purpose of Burnham.

He was born in about 1840, and his first catalogue of double stars was published in 1873, and contained eighty-one pairs. In 1894 he received the gold medal of the Royal Astronomical Society, and up to that year he had published nineteen catalogues, containing his discoveries of one thousand two hundred and seventy-four double stars. Of all known pairs under one second of arc in distance Mr. Burnham discovered more than one-half, and he has since augmented the extent of his success. Some large and valuable works in the form of double-star catalogues and computations of orbits have been issued under his authorship in recent years.

THE WORLD'S POTASH.

OLD AND NEW SOURCES OF SUPPLY.

THE potash hitherto used in this country has been chiefly derived from the enormous deposits of potash salts which occur near Stassfurt in the north of Germany. These deposits have been systematically and economically worked, and the trade so well organised that German potash, on account of its cheapness, became the almost exclusive source of the potash required throughout the world. The German source being no longer available, it has become necessary to take stock of other sources of supply, and these are considered in "The World's Supply of Potash," a pamphlet just issued by the Imperial Institute.

In this pamphlet, which forms in fact a miniature encyclopaedia of its subject, both the old and new sources of potash are described, so far as details are available. Certain of these will probably only be utilised so long as the price of potash continues high, but others promise to become active competitors with the Stassfurt deposits, even when prices again fall to their usual level.

The chief use of potash, usually in the form of the chloride or sulphate, is as an artificial manure, for which purpose over ninety per cent. of the world's output is employed. But potash is also essential for numerous chemical industries carried on in this country and for the manufacture of the finest kinds of glass, and the present scarcity is having considerable effects on these industries. The increased production of potash in the United Kingdom from kelp and other vegetable sources referred to in this pamphlet is now under serious consideration.

The price of "The World's Supply of Potash" is one shilling, post free, and application for copies, enclosing remittance, should be made to the Imperial Institute, South Kensington, S.W.

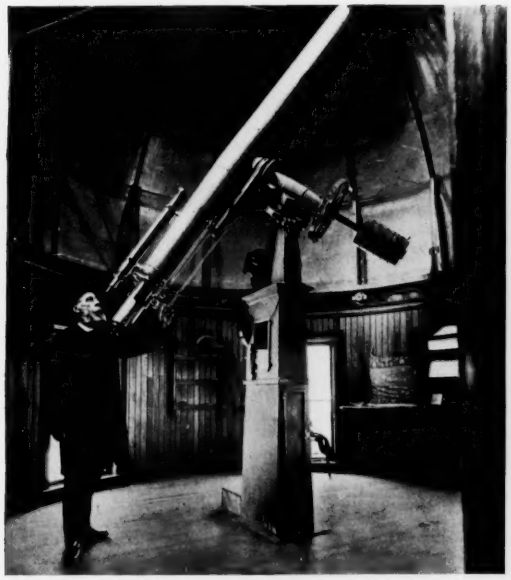

FIGURE 228.
Professor William R. Brooks in his Observatory.

FIGURE 230.
The late Professor Alexander S. Herschel.

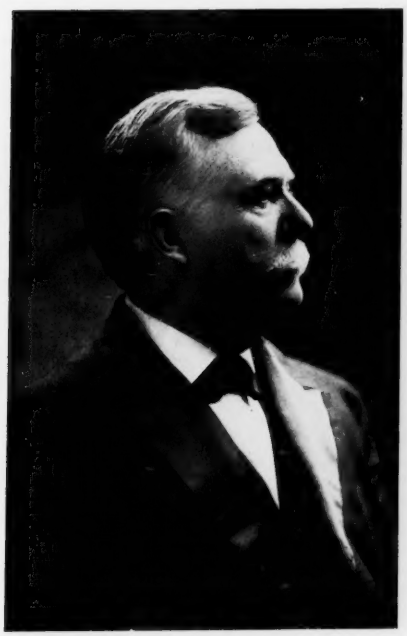

FIGURE 229.
Professor E. E. Barnard.

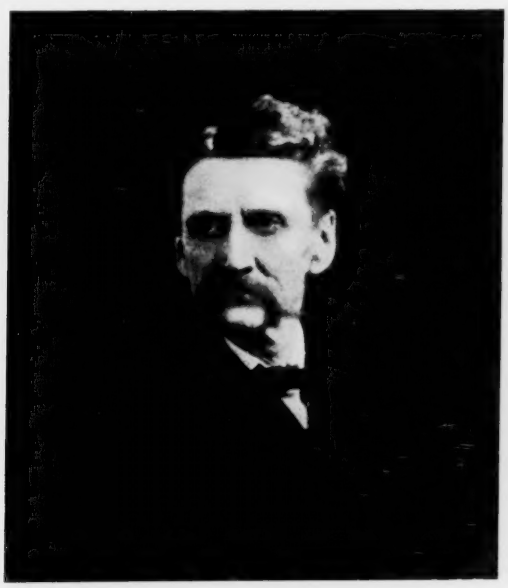

FIGURE 231.
Professor S. W. Burnham.

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FIGURE 232.

(*a*) Long branched and stellate hairs on the leaf-surface of *Draba rupestris*.

(*b*) Individual stellate hair, side view.

FIGURE 233.

Glandular hairs on flower stem of *Saxifraga granulata*.

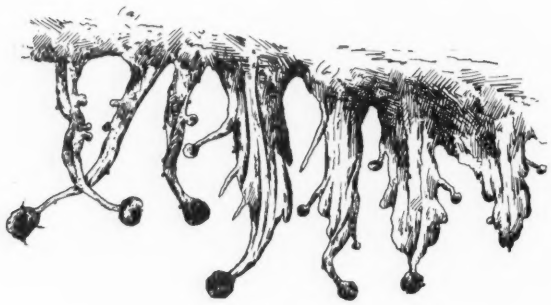

FIGURE 234.

(*a*) Long glandular hairs at base of stem leaf of *Saxifraga lingulata*.

(*b*) Flat pedicelled glandular hairs towards apex of leaf.

FIGURE 235.

Forked hairs on *Leontodon hirsutus*.

FIGURE 236.

Forked hairs on the leaf of Rock-rose.

FIGURE 237.

Glandular hairs on Snap-dragon.

ON THE HAIRS ON ROCK-PLANTS.

By K. E. STYAN.

In a series of articles that appeared in "KNOWLEDGE," Volume XXXIV (1911), May, July, November, and December, on the subject of "Plant-hairs," much matter was set forth as to many of the various wonderful and curious forms, together with their colours and probable uses, and so on. Since the appearance of those articles a great deal more observation work has been carried on, for the most part amongst rock-plants, with a view of ascertaining, if possible, which of the many types of hair-forms most prevail amongst this class of plants; and so great has been the interesting result of this research that the following notes have been compiled in order to increase further the keen interest that was evinced by many readers of the magazine at that past period, and to enable them to see a few more of the strangely shaped hairs that have lately been discovered under the microscope.

In the term "Rock-plants" the writer includes: (1) True alpines, *i.e.*, denizens of the Swiss Alps, and other mountains abroad; (2) those plants that live on the mountain slopes in our own British Isles; (3) species that in lower districts cover cliff-sides, boulders by streams, old walls and rock-ridges generally; (4) those that grow on bare, stone-strewn sides of downs and railway cuttings; and (5) plants that grow on banks where the underlying rock stratum is but scantily covered by a shallow deposit of subsoil, banks that thereby are dry. These many sections of species are included in the term "rock-plants," and it is amongst them that the observation work has been carried out during the last three years.

There is no doubt that, whilst scattered examples of others are met with here and there, three special types of plant-hairs are mainly present, namely: (1) Those that are very long and thread-like, that intertwine in a mycelium-like manner, and those less thread-like, but very slender, sharp-pointed, simple, jointed, or non-jointed; (2) those of stellate, or star-like, form; and (3) those that are glandular, with secreting tips, of quaint shapes and many-hued. Of these three types the glandular are certainly the most abundant, and, after them, the stellate. Taking each kind in its order, the thread-like come first. These frequently give the plants they cover a particularly charming, silky appearance; at other times they appear like thick wool. Every gradation of this is met with, according as the hairs are very dense or otherwise. When very massed, the naked eye sees the effect easily; when thinly grown, the plant may appear merely softly ciliated, or the hairs be almost invisible without the help of a microscope. The well-known Edelweiss is a good instance of a wool-covered alpine, and its ally, the choice Mountain Cud-weed (*Gnaphalium dioicum*) is another lovely example of a plant covered over all its leaf-surfaces with "cotton," *i.e.*, interlacing masses of simple, slender, long white hairs that form a dense "web," or "felt." Whereas the Edelweiss has its flower-stems, bracts, and florets wrapped in the thick white wool, the Mountain Everlasting has its stems thickly clothed, but its bracts and florets less so. The whole effect of the pink and pearly-looking blossoms rising from the silvery leaves, thickly rosetted and very dwarf, is very charming, and no one who has ever seen this lovely plant growing wild on the Alps, or on our own mountain sides, can ever forget the beautiful sight. It can readily be grown in any home rock-garden, and will adorn the smallest piece of boulder with its garb of white all through the year.

Similar hairs are found on the well-known "Snow in Summer" (*Cerastium tomentosum*), another silvery-hued alpine. Every leaf is covered, and every stem is just as softly glistening by reason of the silky, tapering, interlacing hairs that are present.

Many other species cannot here be mentioned, being too numerous to name, but note must be made in concluding this type of the curious "web" that forms over the leaf-rosettes of many of the wonderful Sempervivums, specially round and about the time of blooming. The exquisite *Sempervivum arachnoideum* (which is so named because it resembles a spider's web, on account of its hairy covering) is a plant that becomes almost as white as snow in summer, each tiny rosette of leaves being laced and interlaced all over with the most delicate and chaste web possible. It is a marvel of beauty to the naked eye, and a marvel of beauty when magnified. From the centres of these woven leaf-rosettes rise the short, scale-leaved flower peduncles, each of which bears five beautiful star-shaped, rosy-red blossoms. In an English rock-garden the Sempervivums grow easily, and are a joy to behold: wild, on the rocky mountain slopes, they are an endless source of delight, partly because of their strangeness, but mainly on account of their exquisite blossoms and hairy leaf-rosettes.

From interlacing, simple hairs, we pass on to the second type—the stellate—which build up on many plant species some of the most remarkable "felts" and "webs." Such hairs often impart to the leaves

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and stems they cover, a very silvery white or bluish grey colour, and a glistening, or mealy appearance ; whilst, to the touch, such stems feel very scabrous (or rough and scaly). A particularly lovely example of this may be seen in the case of the Rock Whitlow Grass (*Draba rupestris*) (see Figure 232), a very dwarf-growing alpine, with tiny bluish grey-green rosetted leaves, and small white blossoms. The wee leaves look "mealy," and when examined under the microscope are found to be densely clothed with countless myriads of stellate hairs, as well as others simply branched in such a way that the leaf-surface appears like the coat of a sea-urchin, and covered with sharp, formidable spines. The specimen examined was found by the writer close to the summit of the Niesen, at an altitude of about seven thousand feet. It now lives and thrives in an English rock-garden, on a sunny slope, between three and four hundred feet above the sea-level !

The alpine Aubrietias and Alyssums have their leaves and stems also decked with stellate hairs, as do countless other rock-plant species. For the most part, such hairs show from five to seven rays, but others show from three to four or five to ten, the individual "rays" being simple or else considerably branched.

The third type, the glandular, is very largely present on rock-plants, and very frequently such hairs are met with in conjunction with (1) those that are thread-like ; (2) those that are stellate. At other times they grow alone on the species in question. To enumerate the many "alpine" or other species upon which such glands are found would be too long a task, but it is worth mentioning that the Sempervivums and Sedums (both large classes) show them, and amongst the Saxifrages glandular hairs abound. In this large order of plants a great deal of observation work has been carried on, and some very strange hair-growths discovered since the publication of the previous articles in this magazine.

Specially interesting, and worthy of description, are the hairs on the flower-stem of *Saxifraga lingulata*, one of the choicest of the alpine species, belonging to the class of what are called *Euaeizoön* (*Aezoön*), or encrusted Saxifrages, whose leaves are thick, bluish green in colour, with the margins encrusted with what look like white beads of frost. Up the flower peduncle there are only a few very small leaves (the great mass lie close to the ground in thick rosettes), and it is one of these that is now going to be discussed. Just where the small leaf is inserted on the flower-stem, the leaf-margin shows a series of wonderful hair-prolongations, each with a long, very slender pedicel (sometimes with, at others without, glandular swellings up the sides), and, at the tip, a somewhat large circular, oval, or pear-shaped gland of a rich, red-brown colour (see Figure 234 (*a*)). After these comes a series of other hairs, each of which bears a rather smaller glandular tip, but shows a most extraordinarily flattened pedicel, very much broadened out, and cut up each side into all sorts of quaint-shaped branches, many of which end in a glandular tip of small size. After these, as the apex of the leaf is gradually reached, come more hairs, each becoming shorter, blunter, less branched, and less glandular. The three series together form a most interesting study, for each is really very beautiful in itself, and the whole presents a combination of graduated hair-prolongations that is rarely met with ; in fact, out of the scores of hairs examined the writer has never before come across such a strange combination (see Figure 234 (*b*)). It appears that the leaf-indentations (serrations) form the actual glandular hair pedicels, and all the hairs point mainly towards the apex of the leaf on which they are situated.

In another of the encrusted Saxifrages (*S. granulata*) the flower-stems and calyces are thickly covered with clear white multicellular-pedicelled hairs, bearing each a curiously shaped, ruby-coloured, glandular tip (see Figure 233) ; and *Heuchera sanguisorba*, another member of the same order, bears some which have long pedicels of a clear grey colour, and cup-shaped, glandular tips, which are of a brownish tint. These hairs grow all over the leaf surfaces.

Before leaving the subject of the Saxifrages, it is interesting to note that almost all the species found in the British Isles (of which *S. granulata* is one) show glandular hairs somewhere on their surfaces, on leaves, peduncles, pedicels, and calyces, and that the greater number of such hairs are coloured, the prevailing tints being ruby red and yellowish brown. Some seem to emit a slight odour as well.

There are a few other plants worth mentioning which present some very strange hair-forms, and these are : (1) The Hairy Hawkbit (*Leontodon hirsutus*), which grows in hot, dry positions. The hairs on this plant are forked, but differ from those found on many other plants, in that the forks show three instead of two prongs (with very few exceptions), borne at the tip of a long, multicellular pedicel. These hairs are thickly massed (see Figure 235). (2) Our wild native yellow Rock Rose (*Helianthemum vulgare*), which grows on dry, very sunny, stony banks and downs. The hairs here found, on leaves and leaf-veins, are forked, but in no way resemble the above-mentioned, being, in this case, formed of a bulbous-shaped pedicel and two very long, slender, sharp-pointed prongs (see Figure 236). The hairs are somewhat rough, and impart to the leaf a very scabrous surface. (3) The Garden Snapdragon (*Antirrhinum*), a plant that loves to grow on old stone walls and any very sunny, parched positions. Some very remarkable hairs are here present on the flower stems and calyces, hairs slightly swollen at the base, with long tapering, jointed pedicels, each joint being again

swollen. A curiously shaped gland stands at the tip of each pedicel, and is dull grey in colour. The hair pedicel is clear and silvery (see Figure 237).

If, in conclusion, one pauses to consider the reasons for the presence of these various hairs, in so far as they affect rock-loving plants, there seem to be two main uses for them, both of which, in some cases, go hand in glove together.

Thus, if we consider the case of Saxifrages alone, it is clearly seen that in some respects the glandular hairs *attract*, as well as *protect*. In numbers of cases the stems of Saxifrages may be seen to be covered with wee insects (winged or otherwise), entrapped, and many of them dead. Probably these insects set out to visit the flowers in search of nectar; perhaps, if they reached the blooms, they would cause injury to the essential organs, and in no way aid in the great work of cross-fertilisation. In order, therefore, to safeguard the flowers, the peduncles became clothed with glandular hairs, which, whilst alluring the tiny visitors by means of colours and odours—some hairs emitting a distinct scent—undoubtedly make prisoners of them to a very great extent by means of the glutinous substance secreted in the hair-gland. On the other hand, certain larger insects that may be useful for fertilising the blossoms may be attracted by the hairs, and yet able to move safely amongst them in their passage up the stem and over the calyx leaves. Amongst other plants, the presence of stellate, filiform, and massed simple hairs, that so often form woolly, silky, and felty coats, is probably for protection. When plants are clothed with "fluff," this naturally soaks up all possible humidity, which is so good for them during the period of active growth; the same "fluff," on the other hand, prevents excessive transpiration of the plant's moisture under the burning rays of clear sunlight. So we see that the hairs protect in two ways. In our English gardens such "fluff" on alpines may become a source of danger to the plant possessing it, in so far as it may become sodden all winter, and cause the plant to rot. Buried under the snow the plants are safe. The same reason may be attributed to the web-like surfaces of leaves found on plants growing on very hot, sunny, rock-strewn banks, downs, old walls, and boulders, and so on, as in the Dwarf Mountain Cud-weed, the Mountain Everlasting, Mouse-ear, Hawk-weed, and countless other species.

CORRESPONDENCE.

"KINETOL" AND "THERMATOL."

To the Editors of "KNOWLEDGE."

SIRS,—I have been criticised for introducing the terms "kinetol" and "thermatol"; hence a few words are desirable as to what they mean, and why they are wanted. Kinetol is the kinetic energy of unit mass of a body, and thermatol is the thermal energy of its unit mass. The kinetic energy of a body divided by its mass is its kinetol. Energy is $\frac{mv^2}{2}$, so kinetol is $\frac{v^2}{2}$. When we use unity in a term the unit factor disappears from the products. So mass is not involved in either term. The height to which a vertically moving body will travel is its kinetol, be the projectile a small shot or a massive shell. The height a projectile goes is proportional to the square of its velocity. It is also proportional to the energy divided by its mass. So neither energy nor velocity simply tells the height.

Whenever we are doubtful of the mass, as we are in problems of the minute, such as in atoms and ions, and of the massive as when dealing with dead suns and meteoric swarms, we have to use the idea of kinetol as a phrase, and say the energy of unit mass. Now the idea of kinetol is very commonly wanted in many problems, and is a much simpler idea than that of energy. In using energy to express kinetol, we are practically putting on mass as a useless load, and then taking it off again, after carrying it all the journey. How the term simplifies dynamics may be seen in the articles on "The Graphics of Gravitation."

Thermatol is the absolute temperature of a hypothetical substance whose capacity for heat remains the same at all temperatures, and is equal to water at the maximum density. The scale is graduated from absolute zero; the degrees are Centigrade. It is the number of thermal units in a unit mass. Temperature depends on the specific heat of the substance heated, and the quantity of thermal energy per unit mass. It varies directly as the energy, and inversely as the specific heat. Specific heat varies with the temperature, with differences of pressure, volume, and with differences of chemical composition. The scale of temperature may reckon from absolute zero or the freezing-point; the degrees may be Centigrade, Fahrenheit, or Réaumur. Hence the term "temperature" is unsuitable, for many reasons, as a means to express the intensity of cosmic thermal energy.

The English mechanical equivalent of heat is the potential energy of one pound, one thousand three hundred and ninety feet high. A fall of one thousand three hundred and ninety feet develops a velocity of about three hundred feet a second. So a body moving three hundred feet a second possesses a kinetic energy of unit mass, or kinetol, equivalent to one degree thermatol. An express train has about one-tenth of this kinetol; if its specific heat be one-tenth, and all its kinetic energy be converted into heat by collision, it would be heated one degree. The critical kinetol of a dead sun may be taken as a thousand million times that of an express train. Hence, if a train could collide with the kinetol equal to the critical kinetol of a dead sun, it would be heated to a thermatol of one hundred millions. If the specific heat of the train remained one-tenth, it would be heated to the temperature of a thousand million absolute.

Such, then, are the meanings and simplifying values of these new terms. I am of opinion that no study has such elusively basic difficulties as dynamics and thermodynamics; yet their principles are of prime importance in all physical science, especially in the science of projectiles; hence the necessity for basic simplicity. Kinetol, if I may recapitulate, is the kinetic energy of unit mass of a moving body. Popularly it is the height to which its motion will carry a projectile. Thermatol is the thermal energy of unit mass of a body, and this, divided by the specific heat, gives the absolute temperature.

A. W. BICKERTON.

MOSCOW ROAD, W.

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THE GRAPHICS OF GRAVITATION.

By PROFESSOR A. W. BICKERTON, A.R.S.M.

Their Application to Cosmology.

(*Continued from page* 249.)

The problems of a cyclic cosmos largely relate to dynamics, chiefly kinetics. They involve the dynamics of a particle and of masses of solar dimensions, thermodynamics, and the dynamical theory of gases. The phenomena range through the formation of gaseous and dust nebulae, meteoric swarms and star-clusters; they take in the origin of planets, suns, and cosmic systems of different orders; they also involve the collision of atoms, suns, and systems, and deal with the decay and rejuvenescence of every body and system in the cosmos.

The induction is based on the conservation of matter and energy. We have to deal, not merely with the dissipation or degradation of energy, but also with its elevation; not alone with aggregation of matter, but with its redistribution. We study also the sorting of atoms, and deal with two great aggregating agencies: the one tending to collect heavy elements, as dense bodies in sidereal systems, in certain parts of space, the other tending to expel the light-elements from these collections of suns, and to aggregate them as diffused fields in the vast regions that gravitation has drained of its heavy material.

Thus two contrasted aggregating tendencies have to be considered. The one gravitation, whose two great laws we have already studied; and the other we may call "levitation," as it is based on the varied properties of light-elements, chiefly their high kinetol.

This article will be devoted to applying the graphics of gravitation to the more important of these problems. Their complexity may well appal the astronomical mathematician, especially the official astronomer, as they lie quite outside the ordinary duties of his office.

The study of cosmology is usually considered a province of the astronomer. This induction is not in line with his work—it is really cosmic chemical-physics—hence is rather a matter for the Physical Society than the Astronomical Society; it is also a matter belonging to the Chemical Society. It lies a bit outside of the ordinary work of these two societies, almost as much as it does out of the ordinary work of the Royal Astronomical Society. Until we have a Cosmological Society it is more in the line of the Royal Society, the Imperial College of Science, and the University of London than other learned bodies. Each, however, should treat its own especial parts.

Although appallingly difficult to the ordinary mathematician, singularly enough, most of the problems are pellucidly clear when treated piecemeal by graphics; and, when the several threads are spun, to weave them into the texture of a consistent cosmology is not deterrently difficult.

The study of cylic cosmology shows that for the full comprehension of the problems the dynamics of atoms are as important as the dynamics of suns. Fortunately, with gravitation the same laws apply to both. This, as we have seen, is not true when dealing with other forces.

Let us look for awhile at the class of problems involved. We deal with the energy of the formations of suns and planets from nebulae and from meteoric swarms. We treat of the complete collision and partial impact of cosmic bodies and systems; the structure of stars and meteor-swarms, of primordial and of stellar cosmic systems, and deal with their mutual approach and subsequent penetration and fusion. The solution of these problems involves the consideration of critical and parabolic velocities and kinetols, and the study of augmented energies. These studies tell us of the possible cause, of the ordinary proper motion of the stars, and of the high speed of runaway suns. Critical kinetol tells us also the amount of the thermal energy of the impact of a meteor on our Sun, and on such a sun as Canopus. It helps to solve the heat problems of the great central furnaces of colliding nebulae, as well as those of interpenetrating cosmic systems, such as gave rise to our galactic system. It also hints at the solution of the problem now so interesting to the students of radium—the rebuilding of heavy atoms, such as uranium and thorium, which for hundreds of millions of years have been falling to pieces by expelling helium atoms.

We shall first study the fall of a particle on a sun or planet, and then consider the formation and collision of suns or planets in a system of homogeneous molecules; finally, we shall deal with problems involving heterogeneous elements, and the encounters of complex bodies and systems.

Critical Kinetol and Augmented Energy.

A particle falling on a cosmic body, from rest at infinity, attains a definite velocity: this speed is called the "critical velocity." In the case of the Sun it is slightly less than four hundred miles a second. When the Sun is a little older and denser, it will for a time be exactly that speed. Arrhenius uses this number, and we will do so here. We will call it the "solar critical velocity," and its corresponding kinetol the "solar critical kinetol."

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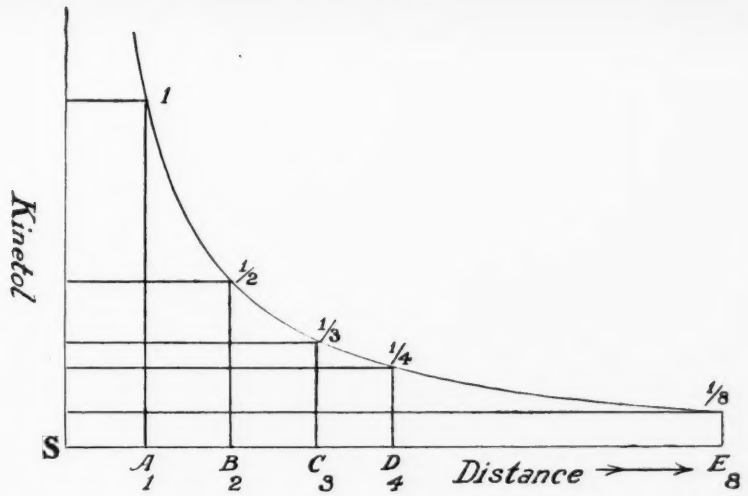

FIGURE 238. Kinetic curve. Each vertical line shows the work required to be done to reach infinity from their respective bases. S, Centre of sun.

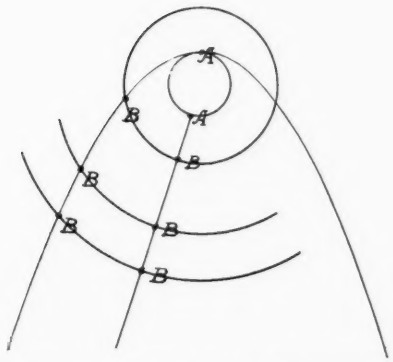

FIGURE 239. At A and A the particles have fallen a light-year: they each have parabolic and critical velocity and kinetol. Each B particle has parabolic velocity and kinetol. Were the particles revolving in the circular orbits, they would have half the parabolic kinetol.

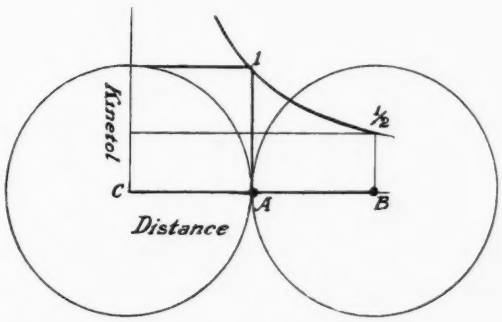

FIGURE 240. Diagram illustrating the contrast of the critical kinetol of a pair of similar suns and of a particle falling on one of them. At B the kinetol is half of that at A. B is the centre of gravity of one of the spheres. Note the particle A falls towards C, the centre. The suns B and C fall towards one another.

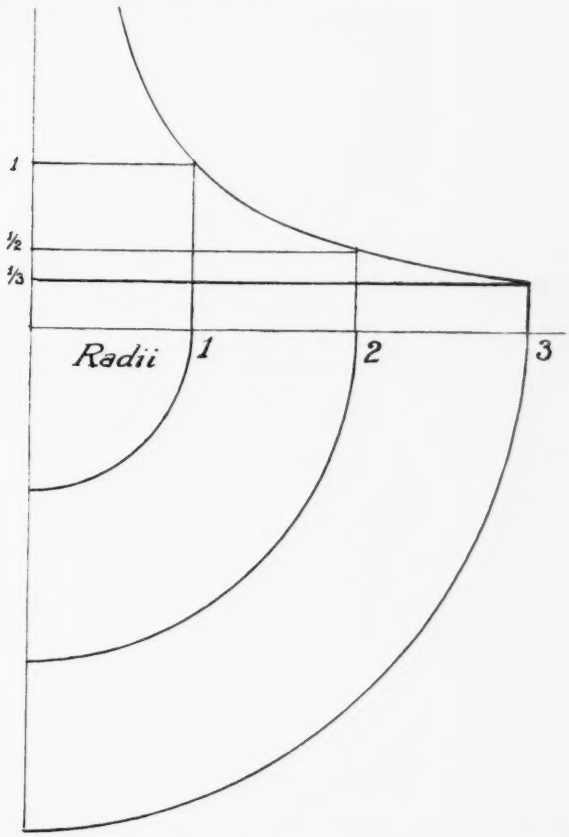

FIGURE 241.—Diagram showing kinetols, and so on, of three spheres of equal density and of radii of 1, 2, and 3 respectively.

	Radii	...	...	1	...	2	... 3
Radii cubed =	Mass	...	...	1	...	8	... 27
$\frac{\text{Mass}}{\text{radius}}$ =	Critical kinetol	...		1	...	4	... 9
$\sqrt{\text{Critical kinetol}}$ =	Critical velocity			1	...	2	... 3

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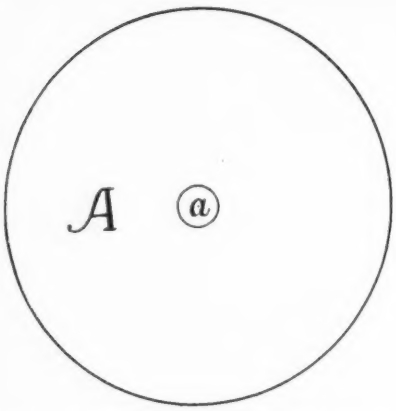

FIGURE 242. A diffused nebula becoming a sun of definite dimensions: volume A, the large sphere of nebula; *a*, the sun comparatively very small, yet of solar volume.

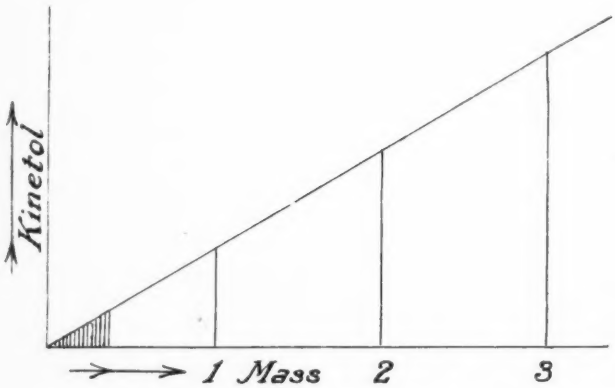

FIGURE 243. Graph of sun forming from a nebula. The horizontal line is mass, the vertical lines are kinetols, the area is energy of formation.

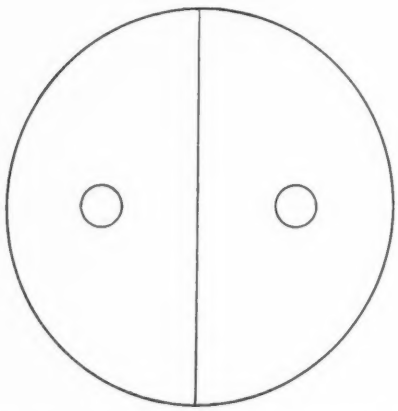

FIGURE 244. A nebula coalescing to two similar suns.

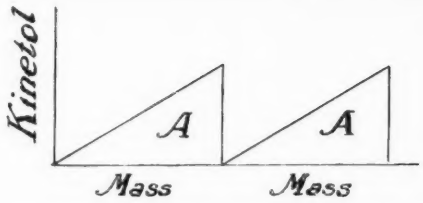

FIGURE 245. Graph of formation of two similar suns. A and A, Energy of formation of each.

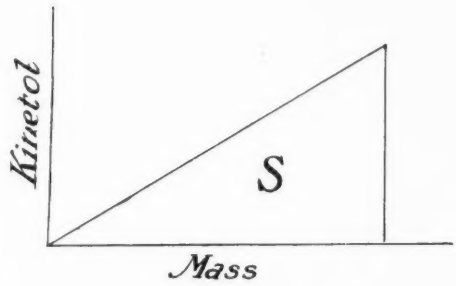

FIGURE 246. Graph of formation of one sun. S, Area of energy of formation.

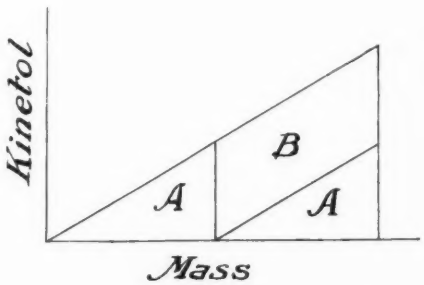

FIGURE 247. Graph of formation of two suns and their coalescence into a single sun: A and A, Energy of formation; B, Energy of coalescence.

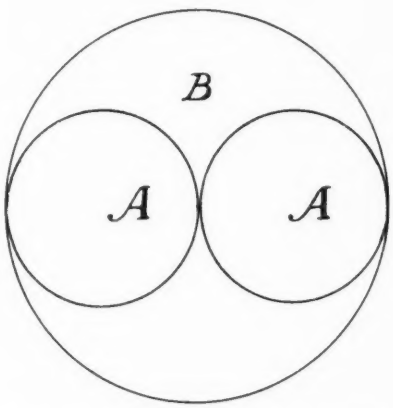

FIGURE 248. Diagram of figure of stability of two completely coalesced similar gaseous suns. A and A, Volumes of the original suns; B, Coalesced sphere in equilibrium.

If we look at the kinetic curve, with its equipotential surfaces, we see that, if we say a light-year, or a parsec, or at stellar distance, instead of infinity, it makes no appreciable difference to solar problems. We are simply dealing with concrete numbers, instead of abstract ideas, and graphics are especially the tools of the concrete.

Although abstract ideas are of extreme importance in the higher mathematics, it is well, if possible, to avoid them in a popular presentment of problems. The term " infinity " is much used, but its concrete meaning varies. A light-year is sufficiently accurate for problems relating to suns, whilst scores of thousands of light-years are required to represent the term when dealing with galaxies.

Let us assume we have a sun whose radius is a million miles. Examine the kinetic curve. It takes half as much work to project a particle to a million miles from the surface as to project it from the surface to infinity; it takes only one-millionth more energy to project it to infinity than to project it to a million radii. Let us look at it by our kinetic curve (see Figure 238).

The line A is twice B, three times C, eight times E; that is, it takes only one-third the work to go to infinity that it does to travel from A to C, and so on. So, if we speak of a light-year or parsec, which is about three light-years, or stellar distance instead of infinite distance, it is accurate enough for solar problems—more accurate than the data. We can thus render the problems diagrammatic, and easily intelligible. Light travels one hundred and eighty-six thousand miles a second. A light-year is consequently $186{,}000 \times 365 \times 24 \times 60 \times 60$, about 6,000,000,000,000 miles; and stellar distance is, say, four or so light-years.

Usually in the solution of cosmic problems the kinetol of a particle is of much greater importance than is its velocity; the kinetic curve is also the simplest of the graphics of gravitation. In falling from rest at stellar distance the kinetol of a particle is inversely as the distance from the centre of the sun or planet, or any other cosmic body under consideration, that it has reached in falling from a light-year's distance. Thus, to take an example, suppose we have a cosmic particle, say a meteor of a ton mass, at rest in clear space a light-year away. It is attracted by the Sun; when it strikes it, it has solar critical kinetol. At a radius of the Sun from its surface it has half that kinetol; at three radii from the centre it has one-third; at a hundred times it has one-hundredth; so an equipotential surface at the distance of Mercury is a little more than one-hundredth part of the kinetol at the solar surface. A body moving in a circular orbit has half the kinetol that it would have if it had fallen to its orbit towards the Sun from infinity (say a light-year), and had reached the equipotential surface of the distance of the orbit. We call the speed anywhere in a parabolic orbit the " parabolic velocity," and its kinetol anywhere in an orbit that will just take it to infinity the " parabolic kinetol." What applies to Mercury applies also to any other planet, so the kinetol of any planet in a circular orbit is half the solar critical kinetol divided by its distance in solar radii. That is, the kinetol of a planet is inversely as the radius of its orbit: this is another way of stating Kepler's third law.

If we draw a parabola, with its vertex tangent to the solar surface, and if a particle in this orbit, at its vertex, be at the critical kinetol or velocity at any other point of its orbit, it would have solar parabolic kinetol or velocity (see Figure 239).

The parabolic velocity, on leaving the Sun, is therefore the critical velocity; if a particle left the Sun with this speed, it would just escape the Sun's attraction; and, if it had a slightly higher velocity, it would wander away amongst the stars, and never come back.

AUGMENTED ENERGY.

It is seldom we deal with pure critical or parabolic velocity, or critical kinetol; the critical kinetol of a falling cosmic body is generally augmented by an original proper motion, or by some other body pulling it also. Thus, suppose a body a light-year away from the Sun were then moving towards it with a velocity of four hundred miles a second; if it fell on the Sun it would strike it with twice the energy that it would have possessed had it been originally at rest; its velocity at impact would be $\sqrt{400^2 + 400^2} = 566$. Hence we have to take into account proper motion.

Again, call the critical velocity of the Earth seven miles a second. Supposing a meteor met the Earth, assume that the solar attraction would give it thirty miles a second, the Earth's own velocity to be nineteen miles a second. If it struck the Earth, it would be a case of doubly augmented energy. If it met the Earth fair face to face, we should have dynamically to sum these velocities. The speed would be $\sqrt{7^2 + 19^2 + 30^2}$.

Thus a comparatively small body might plunge into the Earth and easily blow it to pieces. Probably some such body blew a planet to pieces that made the asteroids. The orbit arguments used against this theory were not sound. Saturn's rings were probably formed in a similar way by a big meteor blowing a moon to atoms. The energy in this case would be trebly augmented; the ordinary dynamics of such a mass of particles would tend to convert it into a ring.

The abnormal molecular velocity of the heat of the third cosmic bodies or central furnaces produced by the grazing impact of suns' nebulae or cosmic systems are cases of augmented energy, and will be discussed later.

CONVENIENT CONSTANTS.

It is imperative in cosmic problems to know the relative value of mass motion and heat motion, and it is convenient to know one or two constants. When talking with Lord Kelvin I often gave

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data, and several times he stopped me and considered a moment, and said, "Yes, that is right." So I asked him how he confirmed my data, and he smilingly said, "I have a number of convenient constants in my mind." I took the hint and followed his example.

A particle, moving with a velocity of about three hundred feet a second, has a kinetol equivalent to one degree of absolute thermatol. By thermatol I mean molecular kinetol or heat. In "The Birth of Worlds and Systems" I have shown the imperative necessity for, and the meaning of, the terms "kinetol" and "thermatol." We have called four hundred miles a second "solar critical velocity." It will be shown later on that, without augmented energy, similar suns come into impact at half the critical velocity of a particle falling on one of them.

The latest conclusion of astronomers is that our Sun is of average solar mass and dimensions. If so, dense suns in impact would generally come together at something between two and three hundred miles a second on the average, so that the heat value of three hundred miles a second is a constant of great cosmic value. Three hundred feet a second is equivalent to one degree of thermatol; hence three hundred miles a second is equivalent to five thousand two hundred and eighty feet squared of thermatol; that is, 72,878,400 units.

A body of unit mass falling on a sun with a velocity of three hundred miles a second, by having its mass motion stopped, would develop more heat than would raise twenty-seven million units of water one degree centigrade. As the energy of dynamite is about a thousand units, it would be an explosion having a power some 27·000 times that of the same mass of dynamite.

Were a particle to reach the solar surface after falling a light-year, it would have something like forty thousand times the energy of dynamite. This, then, may be taken to be the energy given to the Sun by every meteor of unit mass that strikes the solar surface. As I have already pointed out in "KNOWLEDGE," in my article on the Sun, this energy is simply the detonator energy. In the case of a big meteoric swarm, the Sun's dynamic energy liberated by this detonating action may be many thousands, or even millions, of times as great; in fact, it would tend to be as the cube of the diameter detonated by the meteoric swarm.

THE CRITICAL VELOCITY AND KINETOL OF PAIRS OF SIMILAR COLLIDING SUNS, OR OTHER PAIRS OF SIMILAR COSMIC MASSES.

Without distortion, the centres of gravity of a pair of similar colliding suns are two radii apart. A particle falling on one of them is only a radius away. Hence the critical kinetol at impact of such colliding suns is only one-half that of a particle falling on either. Again, when a particle falls on a sun, the sun may be considered at rest; so the whole of the fall gives speed to the particle. But two suns, or any pairs of similar cosmic bodies or masses, falling together, divide the distance between them; and this, again, halves the kinetol. So the critical kinetol of a pair of similar suns is one-fourth the critical kinetol of a particle falling on one of them; and, as the velocity varies as the square root of the kinetol, the critical velocity of a pair of similar bodies is one-half of that of either (see Figure 240).

THE SPEED OF IMPACT AND THE DURATION OF SHEARING.

Assuming bodies to be of equal density, their mass is proportional to the cubes of their diameter. The critical kinetol is proportional to the mass divided by the radius. The speed at impact is proportional to the square root of the kinetol.

The masses and kinetols of three spheres of radii 1, 2, and 3 respectively would be masses 1, 9, and 27, and kinetols 1, 4, and 9 (see Figure 241).

Hence the critical kinetol of spheres of similar density is as the radii squared. The critical velocities are as their radii and as the distance through a cosmic body, and the critical velocity increases in the same ratio. If we have two similar pairs of suns, or other bodies of the same density, and there is the same ratio cut away in each case, it takes just as long for a pair of small suns to cut through one another as it takes a large pair. A cut of, say, one-sixth, with solar density, takes nearly an hour.

ENERGY OF FORMATION OF SUNS.

Understanding the meaning of critical kinetol, we will study the formation of a sun in a homogeneous nebula. We will take the simplest case, and assume a definite portion of space as the collecting region (see Figure 242). Let the area represented by the nebula be sphere A, and that of the forming sun *a*. Let its mass to start with be infinitely small, and let it increase by infinitesimals of mass until it has become mass 1 (see Figure 243). The work of the next particle will have a kinetol 1; it then gradually becomes 2, 3, and so on; hence the series of infinitesimals gradually increase in length until the energy area is filled.

The energy of formation is mass squared divided by 2; hence also two suns of the same volume, and one of them ten times the density of the other: the energy of their formation will be as 1 to 100. If, instead of equal volume, the suns started with small nuclei, and retained a constant density as they grew, then the law would be giving a concrete example; with double the radius it would have eight times the mass, and hence eight times the attractive power; but as its radius is 2, its mass would have to be divided by 2 to obtain the critical kinetol, $\frac{8}{2} = 4$.

Problems of constant density, however, belong to another branch of the subject, and will be treated later.

THE COMPLETE IMPACT OF PAIRS OF SIMILAR GASEOUS SUNS.

Let us assume a nebula of the dimensions of a light-year, and assume two centres of concentration, each the volume of the Sun; that is, the suns are two light-seconds, and the nebula one light-year radii respectively, so that the solar dimensions are practically mere points in a nebula, shown in the diagram (see Figure 244) of sensible dimensions.

Let *a* and *a* be two suns formed by the collection, one-half each of the nebula; then the graphics of energy will be A and A (see Figure 245).

In Figure 246 let S be the energy of the formation of the whole nebula into a sun. Now let us imagine first that the two suns are formed, and a complete collision occurs, and the two suns coalesce. Figures 244 and 246 will represent the sequence. First the formation of *a* and *a*, and the coalescence into S. The work is shown in Figure 247, A and A the formation of the two suns, and B the coalescence into the single sun.

In other words, the work of the formation of two similar gaseous suns, and their subsequent coalescence into a single sun, is equal. Working backwards, the energy of a complete collision is one-half that necessary to form a diffused nebula. The same result may be deduced from the dynamical theory of gases, but that is somewhat complex, and were better treated when we are dealing with the equilibrium of free gaseous cosmic spheres. The study of many of the problems of gaseous suns, under the influence of a dozen or so of variables, has led to a new classification of the stars dependent on the quantitative amount of the hydrogen they possess as ensphering shells.

If, instead of making the geometric assumption of equal volume, we take two similar completely colliding gaseous suns, and study what actually happens, we find, on the dynamical theory of gases, that the whole of the energy of collisions is converted into the potential energy of expansion. This energy, using the kinetic curve, gives us a coalesced sun of exactly double the radius of either of the original suns. Hence the actual effect of the coalescence of two similar gaseous suns without augmented energy is that they coalesce into a sphere of double the radius of one of them, and eight times the volume of one; that is, one-fourth of the density (see Figure 248). The resulting sun has the sum of the diameter of the original spheres, and four times the volume of the two. It has one-fourth the density, and the same temperature. As its surface is twice that of the two, its brilliancy is doubled by the collision. Hence the complete collision of two similar gaseous suns results in a sun, or permanent star, of twice the brilliancy; and the complete collision of two dead suns results in a permanent star that may shine a thousand million years. On the other hand, owing to the augmented energy in the third body formed by a graze, a partial impact will be an explosion producing a temporary star or nova, whilst the two struck suns will each have a vast volcano, and will revolve, and may be variable stars. The dynamical possibilities are that the nova, when at its short maximum, may be scores of thousands of times more brilliant than the two struck suns.

The problem is similar to the combustion of dynamite and petrol. A unit mass of petrol has about a dozen times the energy the same mass of dynamite has. But dynamite has the greater "power," because power is the energy expended in unit time.

A nova is an exploding sun, and is the most brilliant pyrotechnic display in the whole realm of nature. Yet a nova formed by the raze of one-tenth from a pair of similar suns has only one-tenth the energy of a complete collision. But a complete collision gives us a star that may last a thousand million years. The third body, the temporary star, produced by a raze is a kind of prodigal sun that uses up its small substance in a brilliant flash. The plunging expender is historic, and the calm, celestial light is simply a useful, peaceful, and prosperous luminary that, instead of going off with a bang, spends its energy in shedding beneficent light and giving joyous life to countless organic beings, and continues to do so for scores of millions of years.

(To be continued.)

COMMON INSECTS AND SPIDERS IN CYPRUS.

By W. P. D. STEBBING, F.G.S.

WHAT a delight any new country is to a stranger, to one who can see all the beauties of the native plants and trees, the charm of the bird-life, the reasons for the structure of the hills, and even the wonders of the six-legged, eight-legged, or even more-legged life, however these may pester and annoy him. To this many-legged life I am now about to refer; but to the plagues of Egypt—the numerous species of flies, the fleas, and the still more unpleasant creatures which an insanitary population in a hot climate tolerates—it is unnecessary to do more than refer. Nevertheless, it may be of interest to note that Nicholas de Martoni writes in 1394 that "throughout the island there are so many fleas that a man cannot sleep at night, and this on account of the pigs which they keep in their houses." But enough of the disadvantages of Cyprus.

The many months without rain in Cyprus seem a boon to an Englishman, but perhaps some would say there are drawbacks. Of a summer's night one is fain to hide oneself

under a mosquito-net, and to turn back the sheets, and knock one's slippers for fear of a scorpion hiding there. Of an evening, and even during the daytime, from June to October, the elusive sandfly is ever ready to dart her infernal little lancet into one. A fairy-like little creature this, and almost invisible on the warpath, but a bloated pink monster who vainly tries to get through the meshes of the mosquito-netting in the morning.

Sitting with a window open and the lamp alight, various strange beasts may make their appearance, and, if not harmful, become annoying by their love-chants, their blundering attempts to get burnt, or their evil smell if killed. Nervous people may shrink from the warningly coloured black and yellow ichneumon-fly, or its yellow cousin with a sting, or still another with an ovipositor as long as its body. They will be like Miss Muffet on her tuffet, when a great hairy, dark brown spider, as night comes on, ventures out of a hole in a wall, or look on with horrified fascination as a harvester with longer legs than they have ever seen before stalks along a white-washed surface, and, stopping, waves about as feelers the longest pair, while bending backwards and forwards their flexible tips.

In England the darkness-loving clothes-moth is the house pest of warm weather, but in Cyprus its unwelcome attentions are taken over all the year round by the silver-fish insect (*Lepisma*). This curious creature likes ancestral, calf-bound books in damp old country houses in England; but in Cyprus it is ubiquitous, and will eat anything. It is found on the hillside under stones, but most of all in houses, behind the pictures and curtains, and in any nook or cranny. It is ravenous for any animal matter. If a pencil or charcoal drawing is fixed with milk it will eat the surface away. An old engraving left in a chest will be gnawed in patches, and neglected pictures and photographs will receive attention. Hence, away spirit of darkness!

In the early summer there will be curses on the heads of the builders of a Cypriote house for using roughly adzed or merely barked saplings as rafters. Here is pabulum in plenty for those that can eat it, so we find this nice soft wood occupied by hundreds of boring grubs. From innumerable holes the powder they make is deposited on everything about the room, and the perfect insects in the shape of small brown beetles, which appear later on, are everywhere. In the later summer the humming of the hornets and ichneumon-flies on their search all over one's room for possible prey may be annoying and startling; and the mason-bee, willing to occupy the bowl of your pipe, a keyhole, or the barrel of a key as a nesting-place, you feel is taking liberties. Building in these semi-tropical climates, instead of being good, is bad. Where insect retreats should be banned, there they are in abundance, and untidiness, if nothing worse, is a natural concomitant. Every hole in a white-washed mud wall is taken possession of by a little spider, which weaves round the mouth a little circular web, and this, by catching every speck of dust, becomes a dirty mark.

Outside nature has more room, and is clean, but there are terrors, if one looks for them, and cannot appreciate the well-thought-out adaptations for their existence, or their place in the scheme of life. Few poisonous snakes, and no dangerous beasts, live in this birthplace of Venus, but the brown and yellow hornet has a nasty temper, and on the hill-side has its nests in many holes. The sluggish scorpion lurks under stones, waiting for the night, as in damper spots does the large and many-legged centipede. The ant of many species, and always busy, forbids repose on every spot. One kind, when the thyme is out, even adds colour to the hillside. She collects the blossoms for the honey in them for food in the nest, and afterwards deposits the little lilac flowers in a ring outside. Later on, this and other species forage for long distances around their homes, for the seeds of many plants which, after use in the nest, are deposited outside in heaps inches high. A miniature Dunsinane Wood of thistle seeds, bits of dead grass, and so on, may make one think the earth is moving, but you have only chanced on the line of a column of ants returning homewards laden with foodstuffs. In and about the house many species are common, but the very small black ant is a particular pest, as it makes its way everywhere preceded by its scouts. It, as well as the others, has to be prevented climbing the legs of the tables by saucers full of water. In the later summer it seems to have a great craving for water, as it makes its way to the edges of jugs to sip their contents. Numbers so lose their foothold, and float away on the surface. Thus drifting, they collect into little patches, the members of which climb on to one another, so, after an absence, one may be surprised to see a black mass floating on the water, which only close observation reveals as a heaped-up collection of living particles, each of which, emulating humans, is ever striving to use its neighbour to get higher.

Flying grasshoppers and locusts of many species people the land, and startle one by the whiz or click with which they spring up and fly off. On the sunburnt hill-side they are all brown-soil or dry-vegetation coloured, and hardly distinguishable when quiet; but one species has crimson wings, another crimson thighs to its leaping legs, and a third flies with a sound like a policeman's rattle slowly turned. Then they suddenly drop, and are again indistinguishable. But they know the hornet when he comes hawking around a bush, and have some expressive movements of preparedness.

At certain times of the year certain insects are ubiquitous. When the tall squills, with a bulb the size of a Spanish onion, have done flowering at the beginning of October, hordes of grasshoppers seize on the spikes of green, juicy seed-vessels and gnaw them up, and, when these are finished, gnaw all the flesh off the stems, leaving them brown sticks. But at the same time thousands of red plant-bugs with black markings make their appearance where few were seen before, and greedily suck the juices. Full fed, they lay their eggs, and in November the hill-side swarms with young ones, and at the same time there may be seen the perfect insects forcing their way as salmon-pink creatures out of their last larval skin. The sun of January, daily increasing in warmth, hatches forth a second species of plant-bug, blackish brown in colour, with a St. Andrew's Cross in yellow-brown outlining its wing-cases. This finds the succulent leaves of the asphodel awaiting it, and on these the creatures of all ages sit and suck till their too-tight skins split, and they walk out of them and start again.

During the summer the loose sandy stretches are covered with little pits; here we see the lair of the ant-lion. An ugly little creature he is when dug out, and with no resemblance to his parent, who, with gauzy wings more delicate than a dragon-fly's, often flutters into the lamp at night; but he has a fine pair of jaws, and to see him throwing backfuls of sand on to the luckless ant that may have slid into his trap is an embodiment of power. Then there is another attractive insect who works in a different way. This is the praying mantis, who in the spring, when all is green, is green himself, but in the summer and autumn brown as a stick. But there is one large early species which, with a raiment of pale green with white spots, is really beautiful. And who so intelligent-looking and wide-awake? The while he is sitting quietly on a log, with his forelegs clasped before him, he is swivelling his head backwards and forwards. If a fly happens to alight to one side, he first glances at it out of the corner of his eye, and then slowly turns round. If the fly, suspicious, goes off, our friend appears quite unconcerned; but if the fly remains, and is in reach, there is a lightning-like movement, and the next that is seen is the luckless fly clasped between the spiny joints of the mantis's two arms. If motionless, a brown female is quite invisible on the soil, but she gives herself away when occupied in the important business of egg-laying. The eggs, when first laid, are a brilliant emerald-green, and, as they are glued together in a mass, form a very bright spot on the soil. But they do not tempt the passing marauder long, as directly the lady has finished her

business she proceeds to cover the mass with earth, and the eggs themselves, if uncovered a day or two after, are found to have turned a dirty brown.

Ants and bees and wasps have been spoken of, but there is another, a relative, who bears a more evil reputation than any. His native name is "sphalangi," and he may be the bearer of the germs of anthrax. In shape this unpleasant creature is ant-like, but is solitary, is hairy instead of smooth, and has a dark brown head with black eyes, a brown thorax and a black abdomen with three silvery spots. Bee-like, this insect owns a sting. The obnoxiousness comes from his preference for carrion if he can get it. With the Cypriote want of cleanliness is second nature, so offal and dead animals are often thrown just outside a house or village, and here this insect, as well as on the hill-side, may be found. A man sleeping outside in the summer—as they often do—may happen to disturb a sphalangi, which stings him, and so gives him this one of the most dreaded of diseases.

Of insects the most attractive are the butterflies, but in Cyprus they do not dominate the insect scene, and do not appeal by their size. Tropical species are the exception, and in the summer far the most of those that catch one's eye are such common types as red admirals, white admirals, clouded yellows, painted ladies, whites, blues, fritillaries, meadow browns, and swallowtails. Of course, armed with a butterfly net many species could be captured—sixty-nine in all have been recorded—but that is the rôle of the collector, not of the nature-lover. In December and January the large cabbage white and the painted lady are still to be seen, and on in the latter month the springing vegetation is beginning to provide for many caterpillars. The first butterfly of the new year that I have seen was a small copper. The cabbage white is as much a pest as in England from her habit of laying her large patches of yellow eggs on garden stuff, to which the moist air of December has given a new lease of life.

Lamplight collecting would have provided a goodly list of moths, but without it there is little to be said about this large section of the insect world. However, it may be noted that the humming-bird hawk moth is very common, and an annoyingly fussy insect in and about a house. It does not obtrude itself till the autumn months, but then, from daylight to dark, it is a nuisance in one's room, especially if a native-built mud-roofed one, with its bare rafters and its reeds and grass as a foundation for the mud. Every corner is investigated in its noisy flight, and it is not averse from creeping between the reeds in its search for a hibernating hole, and kicking down dirt on your head; and then, when it has seen enough, it is as likely as not to buzz up and down the window pane before finding its way out of the open half of the window. Another universal nuisance, or rather pest, among the lepidoptera, but to the forester, not the villager, is the army worm. This hairy caterpillar may almost strip the trees of a pine wood bare, much as do the caterpillars of the oak-roller moth in an oak wood in early summer in England. The army worm begins its depredations in January, and goes on for about four months. During the day each brood protects itself in a tough silken web attached to the ends of the branches, leaving it to feed during the night. When the various broods have stripped a tree bare, they leave it in a body, and proceed to the next suitable tree. Like the fox moth caterpillar in England, the hairs of this grub, if it is touched, penetrate the skin and irritate for days.

To close these disjointed remarks a few words may be said about a very important order of eight-legged creatures, which cannot be passed by in any warm climate. I refer to the spiders, animals worthy of life-long study, but also of interest to the passer-by who has eyes, fewer though they be than those of the spider. One may be walking on the hill when the glint of a jewel suddenly arrests attention. A little closer inspection, and the jewel is seen to be at the bottom of a neat round hole, perhaps three-quarters of an inch in diameter, and four inches deep. The edge of the hole is made firmer with a few grass stems and silk, and prolonged a fraction of an inch above the ground. The insertion of a straw puts life into the buried gems, and the owner angrily follows the straw upwards and stands revealed as a large light brown spider, with four large eyes and four small ones. The underside of her body is velvety black, ringed with orange, a feature that gives her her scientific name, *Tarentula melanogaster*. I have never seen her voluntarily out of her lair, so she is probably a hunter by night; but when out she ought, from the length and strength of her legs, to be a good runner. As she grows to an inch in length of body she is one of the biggest about the countryside, but is not such a feature as the fine lady who spins a large web among the spiny bushes in the summer and waits for prey. Her marking and attitude of waiting on close inspection seem too conspicuous, as she has a strikingly marked brown and silver underside to her scalloped-edged body, and sits with her barred legs arranged in pairs to form a St. Andrew's cross. But the effect is evidently to blend with the background of twigs and brown soil, so she is not seen until the blundering insect is into the web, and then it is too late.

Jumping spiders haunt the rocks, as they do sunshiny places in England; but underneath lives another quite small species, who there masks its untidy silken lair by hanging small stones to it. It belongs to a genus known as the stone-weavers, and the habit may attract or disarm small flies, which are then pounced upon from the shadow. One of the web-weavers is chiefly in evidence from the nests it constructs and suspends among the bare, spiny branches of a hill-side shrub. This nest is of the shape of a teacup, with a cover with the edge drawn out in places to give attachment to the suspending threads. After the nest has been safely hung in this way it is guarded by numberless very tough strands of silk, which cross one another in all directions, and are cemented together. Although the white nest still shows as distinctly as before, no enemy evidently dares to run the risk of getting entangled in such a network.

Down among the bulrushes of the sea-coast marshes lives one of the geometrical web-weaving spiders, who seems to be in partnership with her mate. She seems to like some comfort at night in this damp situation, so she builds herself a conspicuous but nice retreat of leaves and silk, and here the pair may generally be found at home. Another spider, which likes the neighbourhood of water for the creatures it attracts, is also one of the commonest about a house. It is a grey, or brown, thin-bodied thing, with long legs, the sort to be swept away with a broom when out of place; but to see a colony of all sizes, and of both sexes, weaving webs with lightning-like rapidity on a summer's evening is a pretty scene. It likes best some place where the bushes, fringing some irrigation channel, come fairly close together, and give numberless points of attachment for the webs. Here these delicate traps may be seen in tiers one above another, suspended horizontally across the channel. Very rapidly are they destroyed, so it is hoped the builders spend profitable evenings, and make merry during the night.

XUM

THE FACE OF THE SKY FOR OCTOBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 47.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Oct. 3	12 33·8	S. 3·6	8 20·1	N. 20·8	14 3·5	S. 16·0	12 56·0	S. 4·4	7 59·3	N. 21·6	23 31·0	S. 4·8	7 8·6	N. 21·9	20 58·2	S. 17·9
,, 8	12 52·0	5·6	12 25·7	S. 7·2	14 12·7	17·0	13 19·0	7·2	8 11·2	21·1	23 28·9	5·1	7 9·5	21·9	20 58·0	17·9
,, 13	13 10·4	7·5	17 22·5	S. 27·3	14 12·2	16·7	13 42·3	9·7	8 22·6	20·6	23 26·9	5·3	7 10·2	21·9	20 57·8	17·9
,, 18	13 29·0	9·3	22 9·3	S. 9·9	13 59·5	14·7	14 5·9	12·0	8 33·7	20·1	23 25·1	5·4	7 10·8	21·9	20 57·6	17·9
,, 23	13 47·8	11·1	2 2·2	N. 17·7	13 38·8	11·2	14 29·9	14·2	8 44·4	19·5	23 23·6	5·6	7 11·1	21·9	20 57·6	17·9
,, 28	14 6·9	S. 12·9	6 20·0	N. 26·5	13 23·2	S. 7·9	14 54·3	S. 16·3	8 54·7	N. 19·0	23 22·4	S. 5·7	7 11·3	N. 21·9	20 57·7	S. 17·9

TABLE 48.

Date.	Greenwich Noon. Sun. P	Sun. B	Sun. L	Greenwich Midnight. Moon. P	Mars.	P	B	L	T	Jupiter.	P	B	L_1	L_2	T_1	T_2
	°	°	°	°		°	°	°	h. m.		°	°	°	°	h. m.	h. m.
Oct. 3	+26·2	+6·6	59·9	+13·7	Oct. 1	−10·9	+12·1	297·1	3 39 *m*	Oct. 2	−25·4	+2·1	332·6	15·6	2 55 *e*	11 34 *e*
,, 8	26·4	6·3	353·9	+22·2	,, 7	8·9	13·2	239·3	7 36 *m*	,, 9	25·3	2·1	358·5	384·1	2 12 *e*	2 24 *e*
,, 13	26·4	6·0	287·9	+ 1·6	,, 13	6·9	14·2	181·5	11 34 *m*	,, 16	25·3	2·0	24·2	320·4	1 30 *e*	3 10 *e*
,, 18	26·2	5·6	222·0	−20·3	,, 19	5·0	15·2	123·9	3 31 *e*	,, 23	25·2	2·0	49·7	292·5	10 39 *e*	*e*
,, 23	25·9	5·2	156·0	−18·6	,, 25	3·1	16·1	66·3	7 28 *e*	,, 30	−25·2	+2·0	75·1	264·5	9 57 *e*	*e*
,, 28	+25·3	+4·7	90·1	+ 3·3	,, 31	− 1·3	+16·9	8·8	11 24 *e*							

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. T is the time of transit of the zero meridian across the centre of the disc. In the case of Jupiter System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1 T_2 multiples of $9^h\ 50^m{\cdot}5$, $9^h\ 55^m{\cdot}6$ respectively. In the case of Mars apply multiples of $24^h\ 40^m$.

The data for the Moon and Planets in the Second Table are given for Greenwich Midnight, *i.e.*, the Midnight at the end of the given day.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving Southward at a slackening rate. Its semi-diameter increases from 16′ 0″ to 16′ 8″. Sunrise changes from $5^h\ 59^m$ to $6^h\ 56^m$; sunset from $5^h\ 41^m$ to $4^h\ 32^m$. There is now considerable solar activity, and a constant watch should be kept on the disc.

MERCURY is an evening star till the 22nd, having attained its greatest elongation 26° E. of Sun on September 28th. Semi-diameter increases from 3½″ to 5″, then diminishes to 4″. Illumination diminishes from ½ to zero, then increases to ¼.

VENUS is an evening star, but badly placed, having been in superior conjunction with the Sun on September 12th. Semi-diameter 5¼″, illumination nearly Full. 3½° N. of Mercury $17^d\ 6^h e$, 4′ N. of α Librae $26^d\ 8^h e$.

THE MOON.—Last quarter $1^d\ 9^h\ 44^m\ m$. New $8^d\ 9^h\ 42^m\ e$. First quarter $15^d\ 1^h\ 51^m\ e$. Full $23^d\ 0^h\ 15^m\ m$. Last quarter $31^d\ 4^h\ 40^m\ m$. Perigee 11^d Noon. Apogee $27^d\ 11^h\ m$, semi-diameter 16′ 25″, 14′ 45″ respectively. Maximum librations 5^d 6° E., 10^d 7° N., 18^d 6° W., 24^d 7° S., November 2^d 7° E. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 51).

MARS is a morning star, rising about $11^h\ e$. It is 2° South of γ Cancri on 20th. Semi-diameter 3¼″, width of defective lune ⅜″. The North Pole of the planet is now turned towards the Earth, but the South Pole to the Sun, till the 19th, when the Vernal Equinox of the planet's northern hemisphere takes place, the planet being in the part of its orbit that corresponds with March on Earth. Mars is occulted by the Moon on 3rd (see Table 51).

JUPITER was in opposition to the Sun on September 17th, and is now an evening star. It is in Pisces: Equatorial diameter 49″, Polar 46″. Defect of illumination on East Limb ⅐″.

Configuration of satellites at $10^h\ 30^m\ e$ for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.		East.		Day.	West.		East.	
Oct. 1	13	○	24		Oct. 17	32	○	4	1●
,, 2	3	⊙	24		,, 18	3⅔	○	4	
,, 3	32	○	41		,, 19		○	31⅔	
,, 4	431	○		2●	,, 20	1	⊙	43	
,, 5	4	○	132		,, 21	⅔	○	13	
,, 6	412	○	3		,, 22	41	○	23	
,, 7	42	○	13		,, 23	43	○	12	
,, 8	41	⊙	2		,, 24	4321	○		
,, 9	43	⊙	2		,, 25	4321	○		
,, 10	⅔2	○	1		,, 26	4	○	312	
,, 11	3412	○			,, 27	41	⊙	3	
,, 12		○	4⅔2		,, 28	24	○	13	
,, 13	12	○	43		,, 29	1	○	2⅔	
,, 14	2	○	134		,, 30	3	○	124	
,, 15	1	○	324		,, 31	321	○	4	
,, 16	3	○	124						

The following satellite phenomena are visible at Greenwich:—$1^d\ 1^h\ 58^m\ m$ I. Tr. I., $2^h\ 19^m\ m$ I. Sh. I., $4^h\ 15^m\ m$ I. Tr. E., $6^h\ 53^m\ e$ III. Tr. I., $8^h\ 20^m\ e$ III. Sh. I., $9^h\ 47^m\ e$

III. Tr. E., $11^h\ 16^m$ *e* I. Oc. D., $11^h\ 22^m$ *e* III. Sh. E.; $2^d\ 1^h\ 53^m\ 59^s$ *m* I. Ec. R., $8^h\ 24^m$ *e* I. Tr. I., $8^h\ 48^m$ *e* I. Sh. I., $10^h\ 41^m$ *e* I. Tr. E., $11^h\ 5^m$ *e* I. Sh. E.; $3^d\ 2^h\ 13^m$ *m* II. Tr. I., $3^h\ 2^m$ *m* II. Sh. I., $5^h\ 43^m$ *e* I. Oc. D., $8^h\ 22^m\ 51^s$ *e* I. Ec. R.; $4^d\ 8^h\ 24^m$ *e* II. Oc. D.; $5^d\ 0^h\ 5^m\ 13^s$ *m* II. Ec. R.; $6^d\ 6^h\ 11^m$ *e* II. Tr. E., $7^h\ 12^m$ *e* II. Sh. E.; $8^d\ 3^h\ 43^m$ *m* I. Tr. I., $10^h\ 11^m$ *e* III. Tr. I.; $9^d\ 0^h\ 22^m$ *m* III. Sh. I., $1^h\ 1^m$ *m* I. Oc. D., $1^h\ 7^m$ *m* III. Tr. E., $3^h\ 23^m$ *m* III. Sh. E., $3^h\ 49^m\ 13^s$ *m* I. Ec. R., $10^h\ 9^m$ *e* I. Tr. I., $10^h\ 43^m$ *e* I. Sh. I.; $10^d\ 0^h\ 26^m$ *m* I. Tr. E., $1^h\ 0^m$ *m* I. Sh. E., $7^h\ 28^m$ *e* I. Oc. D., $10^h\ 18^m\ 6^s$ *e* I. Ec. R.; $11^d\ 6^h\ 52^m$ *e* I. Tr. E., $7^h\ 29^m$ *e* I. Sh. E., $10^h\ 40^m$ *e* II. Oc. D.; $12^d\ 2^h\ 41^m\ 20^s$ *m* II. Ec. R., $5^h\ 24^m\ 53^s$ *e* III. Ec. R., $6^h\ 26^m\ 44^s$ *e* IV. Ec. D., $8^h\ 53^m\ 39^s$ *e* IV. Ec. R.; $13^d\ 5^h\ 39^m$ *e* II. Tr. I., $7^h\ 0^m$ *e* II. Sh. I., $8^h\ 29^m$ *e* II. Tr. E., $9^h\ 50^m$ *e* II. Sh. E.; $16^d\ 1^h\ 32^m$ *m* III. Tr. I., $2^h\ 47^m$ *m* I. Oc. D., $11^h\ 54^m$ *e* I. Tr. I.; $17^d\ 0^h\ 38^m$ *m* I. Sh. I., $2^h\ 11^m$ *m* I. Tr. E., $2^h\ 55^m$ *m* I. Sh. E., $9^h\ 13^m$ *e* I. Oc. D.; $18^d\ 0^h\ 13^m\ 26^s$ *m* I. Ec. R., $6^h\ 21^m$ *e* I. Tr. I., $7^h\ 7^m$ *e* I. Sh. I., $8^h\ 38^m$ *e* I. Tr. E., $9^h\ 24^m$ *e* I. Sh. E.; $19^d\ 0^h\ 58^m$ *m* II. Oc. D., $6^h\ 20^m$ *e* III. Oc. R., $6^h\ 37^m\ 47^s$ *e* III. Ec. D., $6^h\ 42^m\ 14^s$ *e* I. Ec. R., $9^h\ 25^m\ 42^s$ *e* III. Ec. R.; $20^d\ 7^h\ 59^m$ *e* II. Tr. I., $9^h\ 17^m$ *e*, IV. Tr. I., $9^h\ 37^m$ *e* II. Sh. I., $10^h\ 48^m$ *e* II. Tr. E., $11^h\ 57^m$ *e* IV. Tr. E.; $21^d\ 0^h\ 27^m$ *m* II. Sh. E.; $22^d\ 6^h\ 35^m\ 33^s$ *e* II. Ec. R.; $24^d\ 1^h\ 41^m$ *m* I. Tr. I., $2^h\ 33^m$ *m* I. Sh. I., $11^h\ 0^m$ *e* I. Oc. D.; $25^d\ 2^h\ 8^m\ 51^s$ *m* I. Ec. R., $8^h\ 8^m$ *e* I. Tr. I., $9^h\ 2^m$ *e* I. Sh. I., $10^h\ 25^m$ *e* I. Tr. E., $11^h\ 19^m$ *e* I. Sh. E.; $26^d\ 5^h\ 27^m$ *e* I. Oc. D., $6^h\ 48^m$ *e* III. Oc. D., $8^h\ 37^m\ 39^s$ *e* I. Ec. R., $9^h\ 48^m$ *e* III. Oc. R., $10^h\ 40^m\ 26^s$ *e* III. Ec. D.; $27^d\ 1^h\ 27^m\ 2^s$ *m* III. Ec. R., $4^h\ 52^m$ *e* I. Tr. E., $5^h\ 48^m$ *e* I. Sh. E., $10^h\ 20^m$ *e* II. Tr. I.; $28^d\ 0^h\ 15^m$ *m* II. Sh. I., $1^h\ 10^m$ *m* II. Tr. E.; $29^d\ 9^h\ 12^m\ 35^s$ *e* II. Ec. R. Eclipses occur low right of the disc, taking the direction of the belts as horizontal. Both phases of the eclipses of III. and IV. are visible.

SATURN is a morning star in Gemini. Angle P $-7°\cdot1$, B $-24°\cdot0$. Polar semi-diameter $8\frac{1}{2}''$, Major axis of ring $42''$, minor $17\frac{1}{4}''$. Eastern elongations of Tethys (every fourth given) $2^d\ 6^h\cdot2\ e$, $10^d\ 7^h\cdot5\ m$, $17^d\ 8^h\cdot7\ e$, $25^d\ 9^h\cdot9\ m$; of Dione (every third given) $5^d\ 8^h\cdot1\ m$, $13^d\ 1^h\cdot2\ e$, $21^d\ 6^h\cdot3\ e$, $29^d\ 11^h\cdot3\ e$; of Rhea (every second given) $6^d\ 1^h\cdot6\ m$, $15^d\ 2^h\cdot5\ m$, $24^d\ 3^h\cdot4\ m$. For Titan and Japetus E., W. stand for Eastern and Western elongations; S., I. for Superior and Inferior Conjunctions. Titan $2^d\ 4^h\cdot2\ e$ E., $6^d\ 2^h\cdot6\ e$ I., $10^d\ 1^h\cdot0\ e$ W., $14^d\ 2^h\cdot2\ e$ S., $18^d\ 3^h\cdot4\ e$ E., $22^d\ 1^h\cdot8\ e$ I., 26^d noon W., $30^d\ 1^h\cdot1\ e$ S. Japetus 10^d noon I., $29^d\ 2^h\ e$ W.

URANUS is an evening Star. Semi-diameter $1\frac{1}{4}''$.

NEPTUNE is a morning Star in Cancer. On 3rd R.A. $8^h\ 18^m\cdot2$, N. Dec. $19°\cdot3$, on 27th R.A. $8^h\ 19^m\cdot4$, N. Dec. $19°\cdot3$. Semi-diameter $1''$. $1\frac{1}{2}°$ South of Mars on 11th, $7^h\ e$.

COMETS.—Mellish's Comet, *a* 1915, may be seen as a morning star in Canis Major and later in Orion. It was easily visible to the unaided eye in the Southern hemisphere in June, with a tail 4° or 5° in length. It was detected by several ship's officers, who had not previously heard about it. It passed over the Lesser Magellanic cloud.

The following Table gives its positions at 12^h p.m.

	R.A.	S.Dec.		R.A.	S.Dec.
Oct. 3.—6^h	$12^m\ 22^s$	16° 56′	Oct. 19.—5^h	$47^m\ 42^s$	13° 24′
„ 7.—6	7 19	16 7	„ 23.—5	39 45	12 21
„ 11.—6	1 32	15 16	„ 27.—5	31 10	11 14
„ 15.—5	54 59	14 22	„ 31.—5	22 3	10 1

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
July—Oct. ...	355	+ 72	Swift, short.
Aug.—Oct. 2	74	+ 42	Swift, streaks.
Sept. 28–Oct. 9	320	+ 40	Slow, small.
Oct. 1 ...	262	+ 63	
„ 2 ...	230	+ 52	
„ 3 ...	133	+ 79	
„ 4 .	310	+ 79	
„ 5 ...	98	+ 43	
„ 6 ...	316	+ 59	
„ 7 ...	31	+ 18	
„ 8 ...	77	+ 31	
„ 9 ..	100	+ 13	
„ 10 ...	35	− 10	
„ 11 ...	13	+ 6	
„ 12 ...	42	+ 55	
„ 13 ...	192	+ 83	
„ 14 ...	133	+ 68	
„ 15 ...	31	+ 9	
„ 16–25 ...	92	+ 15	Orionids.
„ 26 ...	43	+ 12	
„ 27 ..	45	+ 27	
„ 28 ...	44	+ 5	
„ 29 ...	109	+ 23	

GREENWICH TIMES OF MERIDIAN TRANSIT OF CERTAIN BRIGHT STARS.—These are given to facilitate the determination of time by observations with small transit instruments. The times for intermediate days may be obtained by simple interpolation. The Greenwich time of the stars crossing the meridians of other places may be obtained by expressing the longitude of these places in time, diminishing them by $9^s\cdot83$ per hour, and proportionately for fractions of an hour, then applying the result to the tabular time—positively for West longitudes, negatively for East ones.

TABLE 49.

Day.	Altair. N. Dec. 8° 39′.	α Cygni. N. Dec. 44° 59′.	β Pegasi. N. Dec. 27° 38′.
	h. m. s.	h. m. s.	h. m. s.
Sept. 28	7 20 44·91 *e*	8 12 29·30 *e*	10 33 14·46 *e*
Oct. 8	6 41 25·27 *e*	7 33 9·59 *e*	9 53 54·95 *e*
„ 18	6 2 5·63 *e*	6 53 49·87 *e*	9 14 35·41 *e*
„ 28	5 22 45·99 *e*	6 14 30·14 *e*	8 35 15·83 *e*

SUN before clock Oct. 1, $601^s\cdot75$, Oct. 6, $695^s\cdot02$, Oct. 11, $778^s\cdot75$, Oct. 16, $850^s\cdot98$, Oct. 21, $909^s\cdot58$, Oct. 26, $952^s\cdot19$, Oct. 31, $976^s\cdot58$. These are the equations of time for the moment of solar transit at Greenwich.

DOUBLE STARS AND CLUSTERS.—The tables of these, given three years ago, are again available, and readers are referred to the corresponding month of three years ago.

VARIABLE STARS.—Stars reaching their maxima in or near September, 1915, are included. The lists in recent months may also be consulted (see Table 50).

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TABLE 50. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m. s.	° ′		d.	
RX Cephei	0 43 9	+81 30	7·4 to 7·9	130	1915—Oct. 9
U Ceti	2 29 39	−13 31	6·6 to 12·7	235	,, Nov. 13
RS Herculis	17 18 9	+23 0	7·5 to 12·8	220	,, Nov. 7
R Sagittarii	19 11 42	−19 27	7·0 to 13·5	269	,, Oct. 31
RT Cygni	19 41 15	+48 34	6·6 to 12·2	190	,, Oct. 29
T Aquarii	20 45 27	− 5 28	6·8 to 13·4	203	,, Oct. 20
V Cassiopeiae...	23 8 1	+59 14	7·1 to 12·6	229	,, Nov. 9

Minima of Algol October $2^d\ 8^h\cdot4\ e$, $5^d\ 5^h\cdot2e$, $17^d\ 4^h\cdot5\ m$, $20^d\ 1^h\cdot3\ m$, $22^d\ 10^h\cdot1\ e$, $25^d\ 6^h\cdot9\ e$, $28^d\ 3^h\cdot7e$. Period $2^d\ 20^h\ 48^m\cdot9$.
Principal Minima of β Lyrae October $7^d\ 10^h\ m$, October $20^d\ 8^h\ m$. Period $12^d\ 21^h\ 47^m\cdot5$.

TABLE 51. Occultations of Stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Time.	Angle from N. to E.	Time.	Angle from N. to E.
1915.			h. m.	°	h. m.	°
Oct. 1 ...	BD+25°·1571	7·0	—	—	10 18 *e*	332
,, 2 ...	WZC 498	6·9	—	—	2 5 *m*	324
,, 3 ...	Mars	—	0 11 *m*	145	0 54 *m*	234
,, 3 ...	μ^2 Cancri	5·4	2 16 *m*	49	2 57 *m*	336
,, 4 ...	BAC 3029	Var.	1 18 *m*	152	1 58 *m*	239
,, 4 ...	WZC 618	7·1	—	—	5 16 *m*	328
,, 5 ...	WZC 662	6·7	—	—	5 31 *m*	302
,, 14 ...	ϕ Sagittarii	3·3	4 38 *e*	78	5 54 *e*	258
,, 14 ...	WZC 1239	7·2	7 14 *e*	89	—	—
,, 16 ...	BD − 19°·5928	6·5	7 33 *e*	50	—	—
,, 17 ...	42 Capricorni	5·3	7 54 *e*	63	9 7 *e*	230
,, 20 ...	BD+2°·4752	6·9	8 27 *e*	100	—	—
,, 23 ...	26 Arietis	6·1	11 43 *e*	342	11 56 *e*	323
,, 26 ...	χ Tauri	5·4	4 50 *m*	137	5 38 *m*	219
,, 26 ...	WZC 341	6·6	—	—	11 36 *e*	228
,, 28 ...	BD+ 26°·1082	7·0	—	—	4 21 *m*	324
,, 28 ...	ϵ Geminorum	3·2	—	—	8 6 *e*	252
,, 29 ...	BAC 2544...	6·3	11 10 *e*	173	11 26 *e*	203
,, 30 ...	WZC 536	7·1	—	—	5 4 *m*	342
,, 30 ...	BD+ 19°·2027	7·0	—	—	11 3 *e*	238
,, 31 ...	δ Cancri	4·2	5 28 *m*	109	6 47 *m*	307
,, 31 ...	WZC 598...	7·9	—	—	5 50 *m*	266

From New to Full disappearances occur at the Dark Limb, from Full to New reäppearances.
Attention is called to the occultation of Mars on the morning of October 3rd.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

THE DISTANCES OF THE STARS.—The Astronomer Royal lately delivered the "Halley" lecture at Oxford on this subject, and also presented a paper to the Royal Astronomical Society on the star parallaxes lately determined at Greenwich by photography. A very notable improvement in accuracy has been obtained in the last decade. To emphasise this I may refer to an article, by H. Sadler, which appeared in "KNOWLEDGE" in February, 1890. He dwelt on the immense uncertainty that existed regarding the distance of even the nearest stars, while the smaller parallaxes were dismissed as wholly untrustworthy. Even at that date better values might have been obtained by a more critical discussion of the data, instead of putting all results on an equal footing. Soon after that publication a new seven-inch heliometer was purchased for the Cape Observatory, and a very accurate determination of the distances of seventeen stars resulted. The heliometer method was as old as Bessel, but experience led to the introduction of many precautions for freeing the results from systematic error. Other accurate series were obtained at Leipzig and Yale; but it was found that with suitable precautions the photographic method was susceptible of greater accuracy than any other. One of these precautions is to take all photographs near the meridian, so that any effect of differential refraction, due to different colours of the stars, is always in the same direction, and does not affect the parallax. Another precaution is to equalise the magnitude of the star and the comparison stars. This is done by making a light screen in the form of a sector of a circle rotate close to the plate, so as to cut off part of the light of the brighter star. Two exposures are taken on the same plate at intervals of six months, so that any distortion of the film is eliminated. Professor Schlesinger, at Yerkes, Professor Russell and Mr. Hinks, at Cambridge, and more recently the Astronomer Royal and Mr. Davidson, at Greenwich, have all produced considerable lists of stellar parallaxes found photographically, the probable error of each being in the neighbourhood of 0″·01. This means that

some idea can be given of the distance of a star whose parallax is 0″·02; stars with this parallax are ten million times as remote as the Sun, or thirty-seven times as remote as Alpha Centauri. There are doubtless several thousands of stars within this limit of distance; and, as we may look for a combined output of at least one hundred per annum, their complete determination is only a matter of a few decades. The Astronomer Royal states that three stellar distances were known in 1838, twenty in 1880, sixty in 1900, two hundred or more now.

The stars specially attacked at Greenwich are those within 27° of the North Pole (the region of the Greenwich astrographic zone), whose centennial proper motion amounts to 20″ or more. There are one hundred and sixty of these stars in the zone whose magnitude is 9·0, or brighter, and sixty at present known whose magnitude is between 9·1 and 9·5. There are estimated to be sixty more of the latter class whose proper motion is not yet found.

It is not desirable wholly to neglect stars with small proper motions, for, judging from analogy, it is quite probable that the Sun has some companions in its flight through space, their motion agreeing with his in magnitude and direction. These would have no proper motion, but a sensible parallax. It is worth while to emphasise the prodigious accuracy which a probable error of 0″·01 implies. A second of arc is the angle subtended by a halfpenny at three and a quarter miles, so a hundredth of a second is subtended by a halfpenny at three hundred and twenty-five miles' distance. In this connection we may recall an anecdote of the late Sir David Gill. In one of his lectures he described the probable error of some measures as being the breadth of a threepenny-bit a hundred miles away. The chairman remarked: "We can well see that our lecturer is a Scotchman, for who else would give a thought to a threepenny-bit a hundred miles away?"

The details are now in print, and the deduced distances of the nearer stars on the list may be given. I express them in light-years, as more familiar to our readers than parsecs. B.D. 68°·278 is at 43 L.Y.; B.D. 80°·238 at 47 L.Y.; B D 71°·482 at 37 L.Y.; B.D. 81°·297 at 54 L.Y.; B.D. 67°·1014 at 47 L.Y.; B.D. 68°·946 at 11 L.Y.; χ Draconis at 29 L.Y. The distances of thirty-three other stars are given: they are all above 60 L.Y.

The absolute magnitudes of the stars are given, this being taken as their magnitude when seen at a distance of ten parsecs. This clearly depends on the spectral type. The stars of F type in the list have absolute magnitude about 4; while those of K type have magnitude about 7. One of these has absolute magnitude 11·2. This must either be an orb of very low-surface brightness or a very small orb; the former seems the more probable.

VARIATION IN THE LIGHT OF NEPTUNE.—Mr. Maxwell Hall announced in 1883 that he had detected a decided variation in the light of Neptune, with a period of 7h 55m. The variation subsequently ceased, so that, if real, it was due to some temporary marking on the planet. He again noticed the variation between February and May in the present year, and deduced the period 7h 50 m, the range in light being half a magnitude. He appeals for observation of the brightness of the planet at the next apparition, which begins in the autumn, and goes on to May. The times when the planet is near a stationary point are suitable, as it can then be compared with the same reference stars for some time. The period found is quite a probable one for Neptune's rotation. We know that there must be considerable polar compression from the rapid motion of the node of the satellite's orbit. This implies a rotation period of the same order as that of the other giant planets. Professor Lowell deduced the period of Uranus to be ten and three-quarter hours from spectroscopic observations. We may hope that he will endeavour to get a determination for Neptune in the same manner.

THE INTERNAL STRUCTURE OF THE EARTH AND THE MOON.—Mr. Harold Jeffreys contributes a paper on this subject to *The Memoirs of the Royal Astronomical Society*. He concludes from the surface of the Earth having the hydrostatic form corresponding to the present rate of rotation, whereas it probably solidified when the rotation was much more rapid, that the outer layers of the Earth are plastic under the strains produced by rotation, and continually take up the form of equilibrium. He favours the theory that the core of the Earth is mainly metallic, like meteors—and gives reasons for thinking that it also is plastic under the forces acting—and takes up the figure of equilibrium corresponding to the rate of rotation. He gives $2\frac{2}{3}$ as the density of the outer shell; $8\frac{1}{2}$ as that of the central region. He then examines the case of the Moon, and concludes that here the forces arising from rotation are not too great to prevent a permanent set of the crust, in which case its form would not correspond to the form of hydrostatic equilibrium under the present forces. He estimates the figure of the Moon from the movement of its equatorial plane under the Earth's action, and deduces that it would be the form of hydrostatic equilibrium at a time when the Moon was so near the Earth that its period of revolution was six and a quarter of our present days. This would support Sir G. Darwin's theory of the birth of the Moon. It is further shown that it is unnecessary to postulate tidal friction as acting now on the Moon to explain the fact that it always turns the same face to the Earth.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

MINUTE STRUCTURE OF BLUE-GREEN ALGAE.—The precise structure of the cell, and particularly of the nucleus, in the Blue-green Algae has been the subject of considerable discussion, the interest in which has chiefly centred around the questions of the presence or absence of a definite nucleus in these plants, and its behaviour during division if present. Since these algae have been rather generally regarded as occupying a very low position in the vegetable kingdom, and as being closely related to the bacteria, every contribution to a knowledge of their structure is of interest. Miss Acton (*Ann. Bot.*, Volume XXVIII) investigated the structure of some of the simplest of the Blue-green Algae, namely, certain members of the family Chroococcaceae, and finds that in these there is never a highly specialised nucleus of the type found in higher plants. There is, however, a gradual transition in the structure of the cell from an almost undifferentiated condition in the lower types to a somewhat specialised one, of which *Chroococcus macrococcus* represents the highest type examined, and *Merismopedia elegans* an intermediate stage. The protoplast consists of a ground substance traversed by a network of delicate threads, with thickenings at the nodal points, these thickenings (plasmatic microsomes) serving as centres for accumulation of reserve materials elaborated by the pigmented parts of the protoplast. In most of the species examined there is no definite demarcation of central and peripheral regions in the cell, but the microsomes in the central region accumulate stainable matter (metachromatin), and those in the peripheral region cyanophycin. *Chroococcus turgidus* is an example of this simple type, and it is suggested that the metachromatin represents a stage in the formation of the true chromatin characteristic of the nuclei of other plants. In *Gloeocapsa* the cells show deeper staining of the network in the central region, perhaps representing a higher stage in specialisation of this region. In *Merismopedia* we have a higher type, with a definite central nucleus-like body, which is, however, not of the same type as the nucleus of higher plants, but simply an accumulation of chromatin or some allied substance at the nodal points of a small definite area in the centre of the cell. This "nucleus" appears to distribute itself gradually along the network after division, appearing again in the centre of the cell prior to the next division, and division of the "nucleus" occurs before it is reached by the ingrowing new cell-wall. In *Chroococcus macrococcus*, the

highest type found, there is a definite " nucleus " and cytoplasm; only the peripheral portion of the former stains deeply with chromatin stains, and it contains a network with chromatic at the nodes, while its interior is probably a sap vacuole. The cytoplasm is simply the ground substance of the other types, broken up by sap vacuoles, which give it a coarsely reticulate appearance, and the plasmatic microsomes are very small and indistinct.

It is suggested that the evolution of nucleus and cytoplasm has taken place along the following lines: excess of food material, elaborated by the light-absorbing pigment, was first stored in the plasmatic microsomes as a carbohydrate (cyanophycin); as more of this was elaborated the reserve in the central region became more complex, and proteid metachromatic granules were formed. In time the accumulation of nucleo-protein became restricted to a very limited area, so as to ensure its equal distribution on division of the cell, this restriction occurring only on division, as in *Merismopedia*; thus, part of the cell became physiologically and morphologically separated on account of its function in connection with division. This area represents a primitive nucleus; later this " nucleus " became stable, and was always present, as in *Chroococcus macrococcus*, the ground substance also changing in character, and forming a definite cytoplasm.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

COMPOSITION OF PAINT VAPOURS.—The toxic action of fresh paint was attributed by Gardner (*Journ. Ind. Eng. Chem.*, 1914, VI, 91) to the formation of carbon monoxide during the absorption of oxygen by linseed oil in the process of drying, and he cited experiments in support of his statements. His conclusions, however, have recently been criticised by Klein (*Journ. Ind. Eng. Chem.*, 1915, VII, 99), who shows that in the method of estimation employed by Gardner carbon monoxide would be produced from the formic acid, which is certainly one of the constituents in the vapours given off by paint, and that there is therefore no evidence of the presence of carbon monoxide in the vapours.

DECOMPOSITION OF WOOD BY FUNGI.—*The Journal of the Chemical Society* (1915, CVIII, 197) contains an abstract of a paper by Dr. C. Wehmer on the decomposition (dry-rot) of wood brought about by fungi, such as *Merulius lacrymans*, *M. silvester*, *Comophora cerebella*, and *Polyporus vaporarius*. In one experiment a specimen of thoroughly rotted pine wood contained fifty-one per cent. of carbon, and yielded fifty per cent. of carbon dioxide, water, and so on, 7·5 per cent. of a dark brown or black powder soluble in water, 17·5 per cent. of glossy dark brown particles (containing sixty-four per cent. of carbon) soluble in alkali, and twenty-five per cent. of an insoluble peat-like residue containing sixty per cent. of carbon, and still showing the microscopical structure of the wood. The substances successively isolated from rotten wood showed increasing proportions of carbon and decreasing amounts of oxygen, while the humus soluble in water was richer in oxygen than the original wood. No free organic acids appear to be formed in the process of rotting, the increased " acidity " of rotten wood being attributed to the presence of the humus. When treated with alkali, the " acidity " is neutralised; but this is due to superficial absorption of alkali by the fibre, since boiling with water is sufficient to restore the acid reaction. *Merulius* species readily attack sugars, leaving a residue of humus.

CARBON DIOXIDE AS A FERTILISER.—It has been shown by Dr. H. Fischer that plants grown under glass in an atmosphere containing considerable proportions of carbon dioxide develop much more rapidly, flower at an earlier period, and give a greatly increased yield of fruit, as compared with those grown in a normal atmosphere. These results have been confirmed by Löbner, who finds, however, that the plants are injuriously affected by this excessive stimulation. The latest experiments of Dr. Fischer, described in a recent issue of the *Zeit. angew. Chem.* (1915, XXXIII, 215), show that the growth of tomato plants is promoted by carbon dioxide in the same way. The plants treated with the gas yielded 4·4 kilogrammes of fruit, as against 2·4 kilogrammes produced by the untreated plants.

PAPYRUS AND PAPER MANUFACTURE.—Mr. W. Beam gives an account of the methods of preparing paper from papyrus in a recent issue of the *Bulletin Wellcome Tropical Research Laboratory*, Khartoum (1915, No. 2). From this it appears that for the successful commercial application of papyrus as a paper material the chief essential is a method of separating the fibro-vascular bundles from the surrounding cellular tissue without the use of chemicals. This can be done by digesting the papyrus stems for several hours in water at 142° to 150° C., and then beating them in a stream of water. The residual useful fibres are of a somewhat dark colour, but yield a colourless pulp when boiled with caustic soda and bleached. By digesting stems containing eight per cent. of moisture for six hours at 140° C. a residue of 40·5 per cent. of dry material was obtained, while a digestion for three hours at 150° C. gave 37·5 per cent. From these residues 55·2 and 54·8 per cent. of dry bleached pulp were prepared. It is estimated that the prepared papyrus is worth about £5 per ton in Egypt, and that the cost of transport would be about £2 per ton.

GEOGRAPHY.

By A. SCOTT, M.A., B.Sc.

THE GEOGRAPHICAL SOCIETY MAP OF EUROPE.—When the war broke out an immediate need arose for maps of the areas concerned. Very few sheets of the projected " Carte Internationale du Monde " had been issued, and although the war areas were covered by the various Government maps, these could not be put in juxtaposition owing to differences in scale, characteristic signs, and so forth. The Royal Geographical Society, therefore, undertook the preparation of a uniform map covering the areas affected by the war, and in a recent paper A. R. Hinks gave an account of the progress of the work. Several sheets have already been issued, and much valuable experience gained by the compilers. The spelling of the names constituted one of the chief difficulties, and, while an attempt has been made to regularise these, it has been found necessary to provide glossaries of Magyar, Czech, and similar names on the margins of the sheets. It has also been found necessary to adopt arbitrary characteristic signs, as the ones suggested for the international map proved unsuitable. The guiding principle throughout has been to render the map useful for military purposes, and at the same time intelligible to English-speaking people.

ORIGIN OF CORAL REEFS.—In an article which appeared in " Nature " in April of this year, W. M. Davis gave a preliminary account of his investigations of coral reefs, undertaken with the aid of grants from Harvard University and the British Association. While agreeing that most of the current theories account for the visible features of the reefs, he concludes that a valid theory can only be derived either from a study of the islands inside barrier reefs, or with the aid of deep borings. The evidence of the central islands of barrier reefs is strongly in favour of Darwin's " subsidence theory," which also accounts most satisfactorily for atolls and the massive elevated reefs of the Fiji group. In the latter case the subaërial nature of the original deposition surface is shown by the presence of eroded limestones. The present elevated position of the reef does not necessarily indicate that the formation took place during the period of emergence. Davis also concludes

that Daly's "glacial-control" theory does not hold for barrier reefs, since, if it did, the "central islands" should be surrounded by cliffs, while, furthermore, the general physiography is not compatible with the idea of the abrasion of pre-glacial reefs by a lowered glacial sea. The author's general conclusion is that, while no absolutely conclusive theory of the origin of reefs is possible, Darwin's explanation is sufficiently probable to be accepted as correct. The report also includes a discussion of many of the local features of the various reefs.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

CORUNDUM.—The great deposits of this mineral in Ontario receive appropriate and exhaustive treatment in a *Memoir of the Geological Survey of Canada* (No. 57), written by the late A. E. Barlow, whose tragic and untimely death in the "Empress of Ireland" disaster all geologists deplore. The principal occurrences of the mineral are in association with nepheline-syenites, and related alkali-syenites and anorthosites, which show an extraordinary diversity of types within short distances. The numerous varieties of corundiferous syenites and the new nepheline-rich rocks which have been discovered render this area of unusual petrographic interest, and their description has resulted in a crop of new petrographical names. All these various rocks in the corundum-bearing area are differentiation products of a highly aluminous magma, representing one phase of plutonic activity, belonging to one petrographic province, and forming a single geological unit. The whole series is characterised by a prominent foliation in close accordance with that of the neighbouring Laurentian granite-gneisses. In fact, the nepheline-syenites and the associated rocks are believed to belong to the pre-Cambrian complex of the Canadian Shield, and to constitute a marginal facies of the Laurentian granite-gneisses where these are intrusive into the crystalline limestones of the Grenville Series.

The characteristic barrel-shaped crystals range from eight inches in length by two in width down to microscopical dimensions, the usual size being two by three inches. The amount of corundum ranges up to thirty-five per cent. in certain corundum-syenite-pegmatites, but the mineral is distributed throughout the rocks in a very irregular fashion. The corundiferous rocks occur in three parallel bands, the longest of which, with some considerable interruption, is about one hundred and three miles long in a north-east to south-west direction, with a maximum width of six miles. This occurrence is undoubtedly the most extensive development of corundum as yet known. The mineral is regarded as unquestionably of magmatic origin, and to have been developed as a primary constituent from a magma supersaturated with alumina.

The growth of the corundum mining industry, which started in 1900, has been both steady and rapid. In 1912 there was a shipment of 1960 tons of graded grain corundum, valued at 239,091 dollars; but a slump in 1913 reduced the production to 1177 tons, valued at 137,036 dollars.

COMPOSITION OF THE HARD PARTS OF CRINOIDS AND ECHINODERMS.—Chemical analyses of the calcareous skeletons of crinoids and echinoderms show that magnesium carbonate is invariably an important constituent (F. W. Clarke and W. C. Wheeler, *Professional Papers of the United States Geological Survey*, Nos. 90-D and 90-L). This is a novel and important result, as it appears destined to throw some light upon the origin of magnesian limestones. The percentage of magnesium carbonate in crinoids ranges from 7·28 to 13·37; in sea-urchins, from 5·99 to 13·47; and in star-fishes, from 7·79 to 14·11. For crinoids, sea-urchins, and star-fishes alike, the proportions of magnesium carbonate are shown to be dependent on the temperature of the water in which the organism thrives. The warmer the water, the higher the amount of magnesium carbonate; but since temperature depends on the depth of the water, as well as latitude, it does not follow that crinoids and echinoderms living in tropical seas are necessarily rich in this constituent. The crinoids from relatively shallow depths in the tropics are highest in the content of magnesium carbonate, and those from the Antarctic or the far north are lowest. The figures for sea-urchins and star-fishes reinforce this conclusion. Hence the inorganic constituents of any echinoderm will have the composition of a moderately magnesian limestone. A few fossil crinoids were also analysed for comparison. These, however, were found to be very much poorer in magnesium carbonate than the present-day species, and the figures show no regularities of any kind.

The reasons for these facts are still very obscure, and require much additional work for their elucidation. The deficiency of magnesium carbonate in the fossil species may be due to the inevitable accidents of infiltration, solution, and so on, suffered during their long entombment in the strata. The facts will also have a bearing on the origin of magnesian and other limestones, but the authors think it unwise to speculate on the insufficient basis of the facts recorded in their two publications.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

THE WEATHER OF SEPTEMBER.—September, the first of the autumn months, is very variable in its character. In some years it has been like one of the spring months, while in others it has proved the hottest month of the year, with brilliant skies and great drought. The mean temperature is materially affected by the reduction in the length of day: nevertheless, in warm autumns, after a cool season, its general character is that of true summer. When the month is fine there is not a more delightful period of the year on account of that peculiar softness and serenity of atmosphere which are seldom experienced in any other month. It was a very warm month in the years 1843, 1846, 1858, 1865, 1868, 1875, 1895, 1898, and 1911. It was a somewhat cold month in the years 1845, 1847, 1860, 1863, 1877, 1887, 1894, and 1912.

The average temperature at Greenwich for September is 57°·3; in 1865 it was as high as 63°·8, while in 1912 it was as low as 53°·1. The average maximum temperature is 67°·3; the highest mean was 76°·4 in 1865, and the lowest 60°·8 in 1912. The average minimum temperature is 49°·1; the highest mean was 53°·7 in 1865, and the lowest 45°·2 in 1877. The absolute highest temperature was 94°·1 on the 8th in 1911, and the absolute lowest 30°·6 on the 27th in 1885. The temperature rose above 90° on three consecutive days in 1906, and on two consecutive days in 1911.

The average rainfall for September is 2·25-in.; the greatest amount was 5·54-in. in 1896, and the least 0·16-in. in 1865. The heaviest fall in one day was 1·38-in. in 1820 on the 18th. The average number of "rain days" (*i.e.*, on which 0·01-in. fell) is 12·3; the greatest number of days was twenty-three in 1896, and the least one in 1865. Fogs are likely to occur during September, especially round the coast.

The average amount of bright sunshine at the Kew Observatory, Richmond, is one hundred and forty-one hours, or thirty-eight per cent. of the possible duration. The average barometric pressure in London for September is 29·973-in.; the highest mean was 30·246-in. in 1865, and the lowest mean was 29·692-in. in 1839.

THE UNITED STATES PILOT CHARTS.—The Pilot Charts of the various oceans, published by the Hydrographic Office of the United States Navy Department, are prepared from data furnished by the Hydrographic Office and by the Weather Bureau. The former collects and

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compiles data on the following features: Ice, coastwise, field, and bay; derelicts; wrecks; buoys adrift; location of fishing banks, whales, and seals; currents, ocean and tidal; variation of the compass; steam and sail routes; discoloured water; rocks, shoals, and other dangers; gale and storm signals of foreign countries; great sea waves; soundings; sailing directions, and so on.

The Weather Bureau collects and compiles data for the following features: Barometric pressure; temperature of the air; average direction and force of the wind; percentages of calms and gales; trade wind limits; percentage of fog; storm tracks, course of and rate of travel; statement of past average conditions of wind and weather; rains, equatorial region, and so on.

It will be seen from the above lists that the Pilot Charts contain a large amount of information which is extremely valuable and interesting, especially to mariners.

MOVING WAVES OF WEATHER.—Mr. H. Helm Clayton, in a paper read before the Royal Meteorological Society on "A Study of the Moving Waves of Weather in South America," said that at the Argentine Meteorological Office daily charts are prepared showing the weather conditions over the oceans surrounding South America in connection with the observations over the land. These charts, although showing the changes of pressure and temperature from day to day in Argentina, do not indicate that these changes are produced by the slow oscillations of the centres of pressure in the areas of high pressure, nor by the progressive west to east movement of the centres of low pressure near latitude 60°. These changes of pressure and temperature seem to be of the nature of waves which usually first appear near the southern extremity of South America, and progressing northward or north-eastward, diminishing in intensity, die out or disappear near the Equator. This fact is evident by following the waves of pressure across Argentina and Brazil. Waves of rising pressure accompany waves of falling temperature, while waves of falling pressure accompany waves of rising temperature, the two appearing to be but opposite phases of the same conditions; but which is cause and which effect remains yet to be determined with certainty.

It is the custom in most meteorological services for the forecaster to make a mental estimate of the changes to be anticipated during the succeeding twenty-four or forty-eight hours. In order to improve on this method, Mr. Clayton believes it is essential to replace estimates by quantitative measurements of expected changes, and to make quantitative forecasts. He gave an interesting example of such a method as applied to one of the Argentine weather maps.

GREAT RANGES OF TEMPERATURE AT CHICAGO.—We frequently hear of the great and sudden changes of temperature which occur in the United States, but we do not always realise their extent. Messrs. H. J. Cox and J. H. Armington, in their recently published book on "The Weather and Climate of Chicago," give some striking instances of such changes. The greatest daily range of temperature recorded in Chicago was 52°, which occurred on February 8th, 1900, from a maximum of 62° to a minimum of 10°. On March 24th, 1891, there was no change throughout the whole of the twenty-four hours, the temperature remaining at 32°. In contrast to this may be quoted the remarkable fall of more than 60° in twenty-four hours. This occurred in November, 1911, during the advent of the severe cold wave of the 11th–12th, chronicled by one of the city newspapers as the one time in the history of Chicago when "one man was overcome by heat and two others frozen to death within the short space of twenty-four hours." At 4 p.m., on the 11th, the thermometer stood at 74°; at 10 a.m. on the following morning the mercury had dropped through 60°; and by 12.30 p.m. (*i.e.*, twenty and a half hours after its highest point of the day before) the instrument showed 13°, thus making the record fall of 61° during any twenty-four-hour period covered by the observations of the Weather Bureau.

With regard to great changes of temperature within a period of one hour the following may be mentioned: On March 26th, 1907, the temperature rose 20° between 3.15 and 4.15 p.m.—from 45° to 65°. This change was due to a shifting of the wind from the lake to a southerly direction. The greatest fall of temperature within the space of one hour occurred on March 26th, 1908, when it fell 30° between 1 and 2 p.m.—from 71° to 41°. The wind was high from the south-west during the morning, but changed to north shortly after 1 p.m.

MICROSCOPY.

By F.R.M.S.

FOCAL LENGTH OF SUBSTAGE CONDENSERS.—Having looked through all the books dealing with microscopy on my shelves—a dozen or more in number—I failed to find any instructions, or even hints, on how to measure the focal length of the substage condenser. It might be urged that there are at least half a dozen methods well known among photographers for finding the equivalent focal length of a single lens or lens system. But many of these involve making measurements from some point or plane in the lens. These were at once ruled out of court as inapplicable for obvious reasons. But consideration led me to try a modification of a well-known plan, which, though not new of course, seems to have been almost universally overlooked by photographers and microscopists alike. Having put this into practice with several condensers, and verified the results (within practically negligible differences) by other methods, it seems to be worth while to explain the procedure in a very elementary way for the help of beginners. Suppose r to be the (linear) ratio of object to image, and f the focal length of the lens, then the conjugate distances are $(1+r)f$ and $\left(1+\frac{1}{r}\right)f$, measured from the nodal planes. If we add these conjugate distances together, we get: (i) $\left(1+r+1+\frac{1}{r}\right)f$; (ii) $\left(2+r+\frac{1}{r}\right)f$; (iii) $\frac{(1+r)^2}{r}f$.

By way of example, let us suppose the object to image ratio happens to be 10. Then $\frac{(1+r)^2}{r}$ becomes $\frac{11^2}{10}$ or $\frac{121}{10}$ or $12\frac{1}{10}$. If, then, we divide the distance B to D (object to image) by $\frac{121}{10}$, or multiply it by $\frac{10}{121}$, we should get the focal length of the lens.

In my case B to D was 13·75. Multiplying by 10 and dividing by 121 gives us 1·136, and so on.

But turn back to expression (ii), namely, $\left(2+r+\frac{1}{r}\right)f$. Now, if r is considerable, say 10, then $\frac{1}{r}$ becomes proportionally small, so that in practice for large values of r we may ignore $\frac{1}{r}$ in connection with lenses of short focus, as substage lenses very usually are. Thus, in the case of a one-inch lens and ten diameters' ratio, the induced error would be in the neighbourhood of one-tenth inch. Thus we simplify matters by saying that the focal length may be found (approximately) by dividing object-to-image distance by ratio-plus-trio.

To put this in practice we may arrange our apparatus thus: A B. C D E. F.

A. The illuminant, *i.e.*, an inverted incandescent gas mantle, with opal or ground glass screen.
B. Condenser lens, with iris diaphragm.
C. Substage lens, to be measured.
D. Stage of microscope with micrometer slip.
E. Objective of microscope.
F. Eyepiece of microscope.

Thus the outfit consists of what practically all microscopists already possess.

The micrometer slip showed $\frac{1}{100}$ and $\frac{1}{1000}$ inch, the inch unit being chosen rather than a millimetre scale merely as a matter of convenience.

The iris of B was closed to exactly one inch diameter, *i.e.*, just, and only just, large enough to pass a halfpenny-piece.

The microscope one-inch objective and four-times eyepiece was focused for the micrometer lines, and left at that without further adjustment.

Then A and B were put as far away from C as was convenient. The distance between the iris of B and the engraved side of the micrometer on the stage was measured as carefully as possible—this in my case was 13·75 inches.

Next the substage lens C was adjusted to give a sharply defined outline circular image of the iris opening of B. The diameter of this image circle was then taken by means of the micrometer. Comparing the size of the image (iris of B) with the size of its image at D gives us the ratio. For instance, in one case the image diameter was exactly 9 of the $\frac{1}{100}$ mark, *i.e.*, ·09. If now we divide 1, the object, by ·09, the image, we get a ratio of 11·11, which, just for the moment, we may write 11. If now we add 2 to this, we get 13; and if we divide 13·75 by 13, we get 1·6 approximately. Anyone with a table of logarithms at hand will find the work simplified. Thus:

$$r = \frac{\text{object}}{\text{image}} \qquad \log r = \log \text{ object} - \log \text{ image}.$$

Calling the distance of object to image K,

$$f = \frac{K \cdot r}{(1+r)^2}$$

$$\log f = \log K + \log r - 2 \log (1+r).$$

Two substage condensers, W and L, we examined in detail. The former, W, permitted the removal of the top lens, thus giving two different focal lengths; the latter allowed the top and middle parts to be removed. In this case, when the lowermost lens only was used, it became necessary to reduce the iris of B to half an inch.

The subjoined table gives the results which may be useful to those who may recognise the initials W and L:

W and L.	Object.	Image.	r.	f.	P.H.
W lens, complete ...	1	·035	28·58	·449	·5
,, top removed	1	·09	11·11	1·04	$\frac{1}{16}$
L lens, complete ...	1	·029	34·48	·37	·4
,, top removed	1	·07	14·29	·85	·8
,, top and middle removed	·5	·085	5·88	1·70	1·8

I also give a table showing the relationship of r and K for various values of r, whence it will be seen at a glance how near $(r+2)$ is to the more exact expression $\frac{(1+r)^2}{r}$.

r.	D.*	r.	D.*
1	4	25	27·04
2	4·5	30	32·03
3	5·3	35	37·028
4	6·25	40	42·025
5	7·20	45	47·022
6	8·16	50	52·02
7	9·14	60	62·016
8	10·12	70	72·014
9	11·11	80	82·012
10	12·1	90	92·011
11	13·09	100	102·01
12	14·08	200	202·005
14	16·07	300	302·003
16	18·06	400	402·0025
18	20·055	500	502·002
20	22·05	1000	1002·002

$$*D = \frac{(1+r)^2}{r}.$$

Finally, a word as to the column headed P.H. in my actual tests. This refers to some confirmatory measurements made by the pinhole method of measuring focal length. The lens part was removed from a dark-ground illuminator, and a card (pill-box-like) lid made to fit. This was capped with thin opaque black paper, and a "pinhole" made with a fine (No. 8) needle. With the substage a sharp image of the iris of B was thrown on to the micrometer scale. The substage was then replaced by the pinhole apparatus, which was racked to and fro until the image was again of the same diameter as with the substage lens. The distance between the pinhole and micrometer gave the equivalent focal length of the lens. As the definition with a pinhole is somewhat elastic, one cannot get very fine results, but the figures obtained in this column agree fairly well, except in the second case, where there is a difference of something over $\frac{1}{16}$-inch.

F. C. LAMBERT, M.A., F.R.P.S.

APIOCYSTIS BRAUNIANA (Näg.).—This little freshwater alga, though not very common is by no means rare:

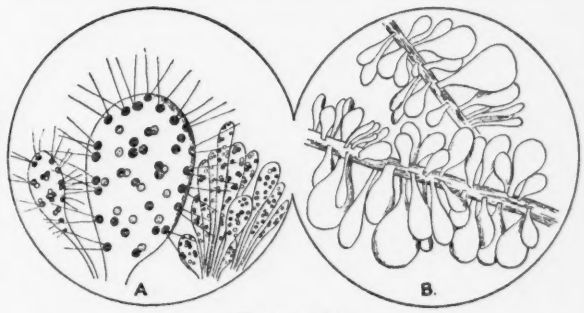

FIGURE 249.

it grows in ponds and ditches and slow-running streams. It has the great advantage of a quite characteristic form, and is consequently easily identified, and, as it may be considered the only species in its genus, there is no doubt about its name. Typically it is pear-shaped, and is usually found attached by the narrow end to water plants and débris, and especially to the coarser filamentous algae (see Figure 249A). Under the microscope the transparent balloon-like body is seen to contain a number of spherical, bright green cells, and careful illumination and adjustment will show that from these two long, very fine hair-like processes extend. These are known as pseudo-cilia: they have no motion, but project through the wall of the vesicle into the water. The cells are the essential portion of the plant, and at a later stage become motile gonidia, and the agents of reproduction. They have an evident cell wall and a chloroplast of the usual character of the Palmellaceae. The vesicle is filled with a somewhat fluid, gelatinous matter, derived from the walls of the rapidly multiplying cells. When these are about to take on the function of gonidia, they move actively in the vesicle, for a time darting from side to side, and "swarming" with a tremulous motion. Soon the wall gives way, and they emerge, and, dispersing in the water, give origin to new plants. Dr. Cooke describes the process as follows: "The young swarm cells (zoöspores) attach themselves by their ciliated point, and become invested with a globe-shaped enveloping

membrane. The first division of the green body then takes place, and is repeated alternately in each direction of space. During this the vesicle, in which the cells (gonidia) lie, continually expands, and generally becomes very evidently pedunculated." The cells are six to eight μ in diameter, and in large specimens are very numerous. Dr. Cooke says there may be up to one thousand six hundred. The vesicle may reach a length of one millimetre (West), its breadth depending chiefly upon the amount of space at command, under normal conditions being usually somewhat less than the length.

Some time ago a fellow-member of the Quekett Microscopical Club sent me specimens of a filamentous alga, which was almost entirely covered with abnormal examples of *Apiocystis*. Obviously in this case the gonidia produced in great quantities had settled in large numbers on the host plant, with the result that the individuals were crowded together closely on the supporting threads, and, having no room to develop in the usual manner, and take a balloon- or pear-like form, they had grown chiefly in length, and presented a dense mass of sausage-shaped objects, quite narrow owing to pressure, but of the ordinary length. I have sketched examples at B (see Figure 249), but found it impossible adequately to represent the crowded mass, which, indeed, was so dense as quite to prevent a satisfactory view of the units with the microscope. At A (lower right-hand figure) I have endeavoured to give some idea of the form of the plants at one of the more crowded places. Dr. Cooke says: "This genus consists of a single species, unless the variety *linearis* of Nägeli is entitled to rank as specifically distinct." It seems to me that the possible variety might have arisen from the occurrence of a similar example to the one described, and this suggestion is corroborated by the fact that in my examples here and there, where an indivdual had managed to some extent to escape the general pressure, it developed in the normal way into a pear-shaped body, instead of the elongated and narrow form which the crowded specimens assumed.

J. B.

PHOTOGRAPHY.

By EDGAR SENIOR.

VARNISH FOR GELATINE NEGATIVES.—It has been found that varnish that answered well for collodion negatives did not offer sufficient protection in the case of negatives taken on gelatine plates when a large number of prints was required to be made from them. Many methods of treatment have been suggested as a means for protecting the gelatine film from the action of the silver salt present on the printing paper, but the one found most efficacious was to apply a coating of plain collodion followed by another of spirit varnish. A collodion suitable for the purpose may be made by dissolving six grains of ordinary tough pyroxyline, such as is used for making collodion for surgical purposes, in half an ounce of methylated alcohol and half an ounce of methylated ether, ·725 specific gravity. If the resulting collodion is allowed to stand for a few days for any undissolved particles to subside, the clear portion may then be decanted off for use. When applying the collodion to the negative, it should not be drained off too closely, but may be allowed to flow back evenly over the surface, and the negative then placed on a level surface until the film of collodion has set. When dry, a thick, impervious coating results, which will prevent brown stains being produced on the negative by the contact of damp sensitised silver printing paper. As a further protection a coating of negative varnish should be given.

SUBSTITUTES FOR VARNISH.—Various substitutes for varnish have been recommended from time to time, such as the following:—

Alum	2 ounces
Tartaric or Tannic Acid ...	60 grains
Water	16 ounces

the negative being immersed in this solution for four or five minutes, too long an immersion loosening the film. Films treated in this manner are almost waterproof.

BLUE-TONED LANTERN SLIDES AND TRANSPARENCIES.—In these days of economy it may be useful to know that stale plates, which we may be afraid to use for fear of fog, as well as negatives that are no longer required, may be made use of for the purpose of obtaining beautiful transparencies quite cheaply. In the case of stale gelatine plates the first thing that is necessary is to remove all the silver salts and harden the gelatine film. This may be accomplished by means of the following solution:—

Hypo	4 ounces
Sodium Sulphite	360 grains
Common Alum	240 ,,
Tartaric Acid	60 ,,
Water	20 ounces

The hypo and soda sulphite are dissolved in a part of the water, and the alum and tartaric acid in the remainder, and when dissolved the alum solution is added slowly to that of the hypo, with constant stirring. The plates are then placed in this solution and allowed to remain for not less than twenty minutes, after which they are well washed, and then dried, when they are ready for sensitising. In the case of negatives they must first be placed in a solution that will remove the silver forming the image. This may be accomplished by means of the ordinary ferricyanide and hypo reducer, the plates afterwards being well washed and then dried, when if the gelatine is at all of a soft nature the plates must be treated with the hardening solution as well. For sensitising the following is to be recommended:—

Potassium Ferricyanide ...	½ ounce
Water	4 ounces
Ferric Ammonium Citrate ...	420 grains
Water	4 ounces

The two solutions are mixed together in equal quantities, and the plates placed to soak in the mixture for three or four hours, when they are taken out, drained, and the surface of the film carefully wiped with a tuft of cotton-wool, when they are placed in a rack to dry. Any drops which form on the film must be carefully removed to prevent markings. The operation of sensitising and drying must be carried out in a dark room. These plates remain in good condition for about a fortnight. When required for use the plate is exposed under a negative in the printing frame as usual, the time varying from three-quarters to one hour, according to the condition of the light and so on. The longer the exposure, the deeper the blue colour. Some idea may be formed by looking at the back of the plate, as when the image shows through in all detail the exposure is generally sufficient. The plate is then removed from the frame and placed in water, which is changed every five minutes for fifteen minutes, after which it is washed for about one hour in frequent changes of water. In the event of the image being under-exposed the plate should be placed —after washing—in a strong solution of oxalic acid for a few minutes. This will intensify the blue colour and improve the appearance of the image generally. If all the operations are conducted with care very satisfactory results will be obtained, the detail in the image being remarkably fine when compared with the ordinary blue print.

PHOTOGRAPHING CLOUDS.—The endless variety of forms and shades of colour assumed by clouds is a very interesting study in many ways, and photographing them, whether for the sake of their forms simply, or with the object of using them in combination with landscapes, is one of the most fascinating branches of photography. The particular kind of clouds which are perhaps the most interesting is the cumulus, which are most frequent in summer, and are rounded spherical forms which look like mountains piled one on the other against the blue sky. Formed in the morning, they generally disappear towards

the evening. The masses of these cloud-forms, when viewed in a favourable light, exhibit a wonderful variety of shades of colour. Usually, to get the best results, it is necessary to photograph such clouds against the light, as by this means the shadows under the clouds present a more pleasing contrast to the cloud-mass itself, giving the appearance of greater depth and volume to the image. One of the chief difficulties met with when photographing clouds is the wind. Some of the most beautiful cloud-forms are often seen on warm, sultry summer days, either before or after rain. After rain the wind is generally higher, and the velocity of the clouds consequently greater, necessitating a much shorter exposure.

Generally it is not found possible to give a longer exposure than a quarter of a second if the clouds are moving at all perceptibly, and in most cases an exposure considerably less than this is ample. Stratus clouds, which are seen most frequently in autumn sunsets as large and continuous horizontal sheets, offer good subjects for the camera; while the nimbus, or rain clouds, while they affect no particular form, and are distinguished solely by a uniform grey tint and by fringed edges, are often worth attention at the hands of the photographer. Some of the best cloud studies are to be found in the autumn, when many subjects which are quite uninteresting at other times become invested with pictorial interest, due to the cloud effects present. Owing to the blue and violet rays having the greatest effect upon a photographic plate a suitable light filter, in conjunction with an orthochromatic or panchromatic plate, will be nearly always required in cloud photography, since if an exposure is made on a white cloud against a blue sky the blue of the sky will act upon the plate almost as strongly as the white cloud, unless a screen is employed to filter out a part of the blue rays, and thereby obtain the proper effect of the cloud. If the screen employed is too dark the sky will have an unnatural blackness. The use of a light filter necessarily prolongs the exposure, but by using a five times screen, with a plate of a speed of 200 H & D and an aperture of F/32 in the lens, in a bright light, an exposure of one fifth of a second was sufficient. In the development of the exposed plate any standard developer will, if carefully used, give the results desired in the image.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.Sc.

THE ELECTRICAL PHOTOMETRY OF STARS.—In a paper read at the meeting of the National Academy of Sciences, April 20th, 1915, Stebbins reviewed the recent work on this subject carried out at the University of Illinois Observatory. The majority of the work has up to the present been performed by the utilisation of the selenium bridge. This is mounted at the focus of the telescope, and the brightness of the illumination is indicated by the consequent diminution of resistance, which is measured by a Wheatstone bridge. The selenium bridge suffers from certain disabilities, the chief of which are that it is especially susceptible to temperature changes, and after exposure to light requires considerable time for recovery. However, it becomes more sensitive and extraordinarily more regular with decrease of temperature, so that for stellar work it is kept surrounded by an ice-pack, the whole apparatus being wrapped up in a blanket.

The selenium bridge bids fair to be displaced for such work by the photo-electric cell, which is more sensitive, and has a shorter recovery period. The photo-electric cell has a sensitive surface of one of the alkali metals, which is mounted in an exhausted glass vessel, with a small residue of inert gas. The effect of light is to release electrons from the surface, which ionise the gas, and thus a current is produced, the intensity of which is a measure of the incident light.

PRODUCTION OF RADIATIONS SIMILAR TO THOSE OF RADIO-ACTIVE BODIES.—The cathode rays of an ordinary vacuum tube are like the β rays from radio-active bodies in so far as they consist of moving negatively charged corpuscles; the α rays are positively charged atoms, and may be likened to the canal rays in a vacuum tube. These canal rays proceed through holes in the cathode, and can be studied in that part of the tube on the other side of the anode. The x rays from a Crookes tube are somewhat similar to the γ rays from radio-active bodies. But the velocities of the cathode rays and canal rays are much less than those of the β and α rays, and the γ rays are much more penetrating than the hardest x rays. To imitate more exactly the natural radiations, enormous voltages would be required (Rutherford, Royal Institution Lecture, June 4th, 1915). For example, to counterfeit the α rays from radium C, a helium vacuum tube, working at four million volts, would be needed. A typical β radiation would demand a vacuum tube, working at two million volts, for its artificial production. The close imitation of γ rays is, on the other hand, not so far beyond the limits of probability, as the frequency of the resulting radiation reaches a definite maximum dependent on the atomic weight of the particular radiator employed.

CONDUCTION OF ELECTRICITY THROUGH METALS.—The discovery by Kamerlingh Onnes of the super-conducting state of some metals, when subjected to very low temperatures, has necessitated the revision of the theory of metallic conduction. The views more or less generally held have hitherto regarded the current as the consequence of the motion of the free electrons in the metal, due to a general drift under the applied electro-motive force. At a recent meeting of the Physical Society of London Sir J. J. Thomson, O.M., F.R.S., explained a theory capable of accounting for the marvellous results of Kamerlingh Onnes. In this theory much stress is laid on the effects of the applied electro-motive force in rearranging the atoms of the conductor. The atoms are pictured as consisting of electric doublets, that is, each atom has a positive and a negative side. When the atoms are rearranged the electric field under which the electrons move will be due, not merely to the applied force, but will have an important component contributed by the field produced by the atoms. The polarisation of the metal increases, therefore, the effective field under which the electrons move. At ordinary temperatures Ohm's law is shown to follow, while in some metals, at low temperatures, the current, once started by the external field, will go on in the absence of an applied electro-motive force, as observed in Kamerlingh Onnes' experiments.

RADIO-ACTIVITY.

By ALEXANDER FLECK, B.Sc.

BEHAVIOUR OF RADIO-ELEMENTS IN PRECIPITATION REACTIONS. II.—An abstract of a paper with the above title, by Fajans and Richter, published in the *Berichte*, appears in the July number of *The Journal of the Chemical Society*. The authors devote considerable attention to the case of thorium-B, starting with the assumption that thorium-B and lead are chemically identical; they then proceed to show that there is a close connection between the completeness of the removal of the active element and the solubility of its salt.

The authors are evidently unaware of the details of the methods by which the similarity between thorium-B and lead was established. It was the consideration of facts similar in every respect to those now brought forward which led to the isotope theory, as at present generally accepted, and also to the conclusion, *inter alia*, that thorium-B and lead are identical. The conclusions reached by the authors are therefore of little value, and were tacitly

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assumed in the initial stages of the work so far back as 1912.

Evidence has also been brought forward (*Transactions of the Chemical Society*, Volume CIII, page 383) which it would be difficult to reconcile with the conclusions reached by the authors, namely, that (1) when the precipitate is an insoluble salt of an isotope the removal of the radio-element is due to solid solution, whereas (2) the removal by precipitates of non-analogous elements is due to adsorption.

GROWTH OF RADIUM FROM URANIUM.—For long it has been believed that uranium disintegrates to give ionium, which in turn breaks down to give radium. The last element is therefore grown from uranium at a definite rate. This conclusion was arrived at, in the first instance, from the fact that the ratio of the quantity of uranium to the quantity of radium in any mineral of considerable geological age has nearly always a constant value.

Professor F. Soddy has from time to time published the results of experiments, some of which were started so long ago as 1905, and which had for their object the direct detection of the growth of radium from uranium. From a theoretical point of view, the experiments are quite simple, but, in reality, they demand a great amount of experience before they can be carried to a successful termination.

Uranyl nitrate was purified by various methods from uranium-X, ionium, and radium, and then placed in aqueous solution in a sealed flask. From time to time the seals were broken, and the solution boiled so that the air which had been in the flask was expelled, and carried with it the emanation in equilibrium with whatever quantity of radium was in the flask at the moment. By a well-known method, the actual quantity of radium can then be deduced.

A new series of measurements has been made, and the results obtained have been published in the August number of *The Philosophical Magazine* in a paper by Professor Soddy and Miss Hitchins. In the experiment with the largest quantity of uranium—three thousand grammes—it is found that in the course of nearly six years the quantity of radium has increased by $7{\cdot}6 \times 10^{-11}$ grammes, which is five times the initial amount present.

In the paper it is shown that previous observations on the growth of radium would be the result of ionium initially present, and that the measurements there given experimentally demonstrate, for the first time, that uranium is actually growing radium through the intermediate stage of ionium.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

THE SMALLEST MAMMAL IN THE PALAEARCTIC REGION.—Mr. Oldfield Thomas describes a new Shrew (*Sorex burneyi*) found by Mr. G. A. Burney near Irkutsk, on Lake Baikal. It is "an excessively small Shrew, smaller than any Sorex previously known." The length of the head and body is fifty millimetres, of the tail 23·5 millimetres, of the very delicate skull 12·5 millimetres—certainly very pigmy dimensions.

MYSIS RELICTA IN THE GREAT LAKES.—Professor A. G. Huntsman calls attention to the abundance of this crustacean in rather deep water in Lake Ontario and other great lakes. It forms a large part of the food of many of the fishes. "The identification of the *Mysis* of our lakes with that occurring in the Scandinavian lakes seems at first sight very surprising. It is impossible for it to have been transported from one place to another. This makes it practically certain that they have both been derived independently from one of the marine species, probably *Mysis oculata*."

PASSING OF PASSENGER PIGEON.—The last known living Passenger Pigeon died from old age on September 7th, 1914, at the Cincinnati Zoölogical Gardens. It had been bred in the Gardens, and was about twenty-nine years old. As is well known, this species used to flourish in the States in quite extraordinary numbers, and even twenty years ago it was abundant in certain parts. With mysterious rapidity, it has become extinct, no wild individual having been seen for years. The Cincinnati specimen has been carefully photographed and dissected by Dr. Shufeldt. He confirms what was long ago described by William MacGillivray in Audubon's great work on American birds.

MOVEMENT OF BLACK-HEADED GULLS.—Large numbers of nestlings of *Larus ridibundus* have been ringed (1909–13) by Mr. H. W. Robinson during the last five years, especially at the Ravenglass Gullery in Cumberland. Of the eight thousand and ninety-six—a prodigious number, as all who have tried "ringing" will allow—marked at Ravenglass, three hundred and forty-five have been recovered, *i.e.*, a little over four per cent. The movement seems to be a general scattering, with a decided southward tendency along west and east coasts. A few returns came from the north and west coasts of France, and three from Portugal, corroborating the general conclusion that there is a south-eastern autumnal migration.

SEX AND SCENT.—The living organism is complex beyond all our telling, wheels within wheels, and correlations of the subtlest sort. It has been known for long—ages before there was any science of sex—that certain odours acted as sexual stimulants. In some of the Moths the males will gather from a distance to the odoriferous female. There are strange correlations between sexuality and the nose in man. Kissing and "rubbing noses" are, it can hardly be doubted to begin with, associated with sex, though both have been, of course, dissociated therefrom in various races. Experiments made by Severin and Severin (*Journ. Animal Behaviour*, 1914) show that exposed kerosene attracts the Mediterranean Fruit Fly (*Ceratitis capitata*) very powerfully. But of the total of five thousand four hundred and ninety-one individuals taken, five thousand four hundred and sixty-one were males and thirty females—a very suggestive fact. But more experiments must be made.

DESTRUCTION OF LICE.—Where clean bodies and clean clothes are necessarily difficult to secure, as in the conditions of war, Lice and other body-pests flourish, and are excessively troublesome. Moreover, there is reason to believe that vermin are responsible for the transmission of the infection of typhus fever, and Nicolle has shown that the Louse can convey the infection. It is therefore of great importance to destroy the Lice. But they are exceedingly tough, able to survive after immersion in water for hours, able to survive prolonged moist heat, able to feed through ointments of most kinds, able to survive dusting with sulphur and camphor, or vapours of turpentine and eucalyptus. After many experiments Dr. J. Parlane Kinloch, Lecturer in Public Health in the University of Aberdeen, has found that petrol is one of the most effective of insecticides. Lice and their eggs are destroyed by immersion in petrol for one minute, and they may be killed by exposure to the vapour of petrol for half an hour. Clothes can be cleaned in a petrol bath, and anointing the body with petrol and vaseline is very effective. Soap preparations containing two per cent. of trichlorethylene, or ten per cent. tetrachlorethane, give good results, and Lice cannot persist on the human body if anointed daily with a twenty-five per cent. solution of trichlorethylene in vaseline. One of the extraordinary instances that Dr. Kinloch gives of the toughness of Lice is that they can be revived after immersion for one minute in water at 100° C.

FIGURE 250. Beech-mast from which the mice have extracted the seeds.

FIGURE 251. A Hedge Sparrow's Nest which has been covered in by a mouse.

FIGURE 252. A Garden Warbler's Nest in which a mouse has placed a partly eaten acorn.

FIGURE 253. A Hazel Nut stuck in the bark of an oak and opened by a Nuthatch.

FIGURE 254. Cones of the Spruce gnawed by Squirrels.

FIGURE 255. Marble Galls of the Oak from which the grubs have been extracted by the Greater Spotted Woodpecker.

Figures 251 and 252 from photographs by Hubert H. Poole; the others from photographs by Wilfred Mark Webb, F.L.S.

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FIGURE 256. The morning party at an Essex Field Club Fungus Foray.

FIGURE 257. Mr. William Cole, the Secretary, and Mr. George Massee, the Referee.

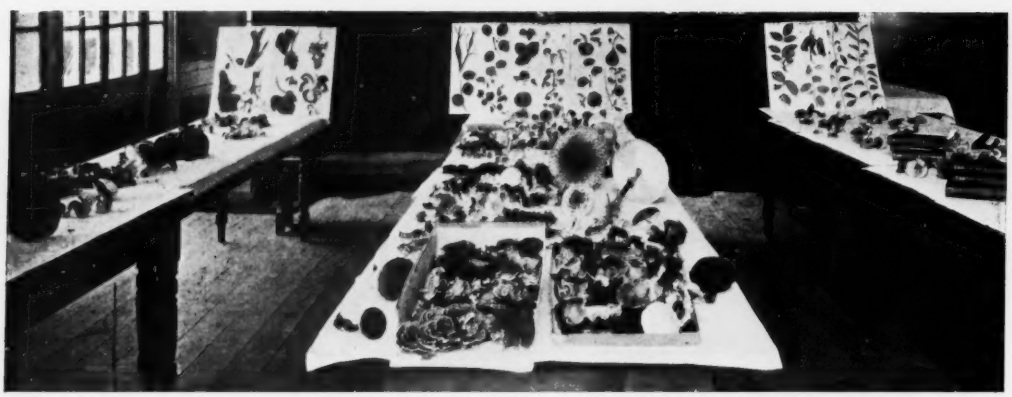

FIGURE 258. Some of the specimens laid out for identification.

INDIVIDUALITY IN DETAIL.—Various illustrations of "specificity" have been given from time to time in these notes, and we would add another illustration. The pigments of the class known as "melanins" are granular in nature, and the granules are often of definite shape. Post has pointed out that a particular shape of granule is characteristic of particular kinds of animals. Thus the pigment granules in the dog are whetstone-shaped, while those of the guinea-pig are short and thick. Lloyd-Jones has more recently shown (*Journ. Exper. Zool.*, April, 1915) that red tumbler pigeons have spherical granules, while in blacks the shape is either spherical or rod-like, or both. It is very interesting to read that "the form of the granules is determined very early in their existence; at a period, in fact, long before they have attained anything like their ultimate size. The mere circumstance of what position the granules eventually come to occupy would seem unable to change their fundamental nature." Thus we see again how far into detail individuality penetrates.

AMPHIBIOUS CIVET.—A very interesting creature, ranging from Malacca to Borneo, is the amphibious civet (*Cynogale bennettii*). It is often called web-footed, but Mr. R. I. Pocock points out in a recent study that the web does not extend farther up the digits than is the case in allied genera. The scent-glands are much simpler than usual. It is in its habits an unusual combination, since it both climbs trees and swims in the water. Mr. Pocock concludes, from the shortness of the tail and from the absence of special muscular development, that the amphibious civet is not very agile in the water. This is corroborated by the narrowness of the hind feet and the feeble development of the indigital webs. It is unlikely that the creature could overtake swift-swimming fishes. It probably watches the retreat of a fish to a place of refuge, and "paddles" quietly to the spot to seize its prey while lying low, with its movements hampered in the confined space—a predatory device frequently practised by others. The vibrissae are long and strong, and probably very important in supplying information as to the whereabouts of a hiding fish, crab, or mollusc. The upward aspect of the nostrils suggests the habit of lying submerged with only the nose above the surface.

MORTALITY OF MALE SALMON.—J. Arthur Hutton, who has worked for many years on the scales of salmon and the story they tell, calls attention to the rarity of cock fish with a spawning mark on their scales. Out of several hundreds of fishes which he has personally examined only two were male fish which had spawned before. From the three hundred and sixty-nine sets of scales with spawning marks sent to him from the Wye from 1908–14, twenty-one were reported as males, giving a percentage of six per cent. But he is inclined to think that "even this number may be too high, because salmon which have spawned before are frequently ugly fish, and for that reason there is a tendency among fishermen who have not had the opportunity of examining large numbers of salmon to describe them as cock fish when they are really hens." It seems to be most exceptional to catch a male kelt. There seems to be little doubt that, at any rate on the Wye, very few cock fish survive to spawn for a second time. A considerable percentage (three and three-quarters to nine and a half) hen fish show more than one spawning mark. One caught in 1913 was returning to the river to spawn for the fourth time.

A GRIM BUSINESS.—It cannot be denied that there are dark corners in organic nature where strange things happen. But we must beware of exaggerating the horrors, and we must not discredit the natural system of things by including in it the diseases of domestic animals, or the fatality of parasites when man transfers himself or his stock to a new environment. Constitutional disease is rarely, if ever, allowed to get a grip of a stock in wild nature. As a pathological kind of variation, a miss instead of a hit, a failure instead of a discovery, it occurs in wild nature, but it is promptly suppressed, and an enormous number of parasites are hardly distinguishable from partners. Indeed, it is not in the interests of a parasite to destroy its host. The cases of Ichneumon Flies, and the like, stand out as exceptional, and would not have persisted unless the parasitic period had been followed by one of independent life. One doubts whether such cases should not be kept by themselves as a subdivision of the carnivorous mode of life. Is eating another creature from the inside so very different from eating it from the outside; or does it matter how many mouthfuls are required? We are asking this question with reference to those thinkers who find carnivorousness tolerable, but ichneumonisation repulsive.

A good instance of grimness has been recently worked out by Messrs. Keilin and Thompson. It concerned a Pipunculid Fly (*Atelenevra spuria*), which lays its egg in the abdominal cavity of a homopterous insect, a species of Typhlocybe. The egg develops into a larva, the larva feeds on its host, and grows. It gradually compresses the organs out of existence; it makes its host's abdomen swell up. It grows, and moults, and turns itself. It eventually works its way out of its still living host, and pupates in the earth. The host is left quite empty when its parasite departs. The case is interesting in itself, and also in its close parallelism to what occurs among parasitic Hymenoptera, such as Braconidae.

NATURE STUDY IN AUTUMN.

As the year begins to draw to a close, those who are studying nature out of doors may not find such a wealth of subjects forced upon their notice, but there are very many, all the same. One that we may mention is the advantage which animals take of the fruits of the earth. Our illustrations show some examples: beech-mast opened by mice (see Figure 250); fir-cones gnawed by squirrel (see Figure 254); nuts from which the nuthatches have taken the kernel; and marble-galls from which the woodpeckers have extracted the grub that was snugly ensconced in the middle (see Figures 253 and 255). The other pictures illustrate storehouses made by mice, which utilise old birds' nests, in some cases making a roof of moss, and in others merely taking acorns, and such like fruits, into the structure (see Figures 251 and 252).

Another piece of work that is best carried on in the autumn is the study of the larger forms of fungi. It is at this time of the year that many Field Clubs hold their Fungus Forays. Figures 256 and 257 show members of the Essex Field Club on the annual excursions for fungi in Epping Forest, while Figure 258 shows a number of the specimens laid out by the morning party for the benefit of those who travel down later in the day, and for identification in the case of fungi which are not recognised by the finders.

W. M. W.

XUM

REVIEWS.

BOTANY.

The Fundamentals of Plant Breeding.—By JOHN M. COULTER, Ph.D. 347 pages. 109 illustrations. 7½-in. × 5-in.

(New York and Chicago: D. Appleton & Co. Price 6/- net.)

In this extremely useful book the author has gathered up the results of recent research along many and various lines, but all tending in the same general direction of improving cultivated plants. The various facts and theories are set forth in a remarkably lucid style, and it would be difficult to find elsewhere such a concise and easily read account of the principles of plant breeding. The author does not espouse any one particular view, or set of views, and disparage others; all are treated in a judicial and eminently sane manner. Although the various topics included in the book have been often handled, and the present state of knowledge and opinion regarding Mendelism, mutation, and various other subjects are hardly reflected in an adequate manner, yet, taken as a whole, the book certainly fulfils the author's purpose, and will be of interest and value to those desiring a simple statement of the principles of evolution and heredity, and of the results that have been obtained by their application to agriculture. It will be of especial value to those who have had no scientific training in biology or agriculture, but who desire reliable and accurate information as to the methods by which modern agriculturists are attempting to solve the great problem of increasing and improving the world's food production.

F. C.

Floral Rambles in Highways and Byways.—By G. HENSLOW, M.A., F.L.S., F.G.S., Etc. 294 pages. 132 illustrations. 7½-in. × 5-in.

(London: Society for Promoting Christian Knowledge. Price 6/- net.)

The output of popular books about plants shows no signs of slackening, nor, as a rule, does the letterpress which accompanies the coloured and black-and-white illustrations with which these books are embellished show any appreciable improvement. The authors of these books seem to be content to trot out the same blend of dull facts, poetical tags, quotations from the herbals, and so forth. The present author, for instance, has published quite a number of books about plants in which the "mixture as before" method is employed and only the name of the book and the arrangement of the ingredients varied. The present book is nicely illustrated, but, apart from some very characteristic passages setting forth the author's peculiar views, it does not appear to differ from scores of other books on plant life.

F. C.

NOTICES.

MESSRS. LONGMANS' LIST contains a number of new books on science for education. The second volume of Mr. Archibald Thorburn's "British Birds" is promised for the autumn, with other works on Natural History, Agriculture, Chemistry, and Physics.

THE AMERICAN GREY SQUIRREL.—Mr. Hugh Boyd Watt has been at considerable pains to collect details as to the distribution of the Grey Squirrel in England, and he has favoured us with a reprint of the interesting article on the subject which he contributed to *The Field* of June 12th. There are now colonies, more or less well established, in London, Surrey, Buckingham, Bedford, Yorkshire, and Dumbarton.

ADDITIONS TO THE ZOÖLOGICAL SOCIETY'S MENAGERIE.—The number of animals registered during the month of July was three hundred and eighty-two. Of these, two hundred and sixty were presented, thirty-four were deposited, forty-five were received in exchange, and forty-three were born in the Gardens. Among these were Puma cubs, Sea Lions, a collection of American Birds, and two Tortoises new to the collection, viz., a Blackish Tortoise and a Baur's Tortoise.

THE LATE MR. HUGH SPOTTISWOODE.—It is with the very greatest regret that we record the death of Mr. Hugh Spottiswoode, who was known to the whole literary world as Director of Eyre & Spottiswoode, the King's printers, and of *The Sphere* and *Tatler*. Mr. Spottiswoode had the gift of making anyone who had a chat with him feel the better for it. Men with this grace of personality are rare, and Mr. Spottiswoode will always be missed by those who had the pleasure of his acquaintance. Many of our readers will remember that Mr. Spottiswoode's father was a distinguished man of science and at one time President of the Royal Society.

THE HOMELAND ASSOCIATION, which is for the encouragement of touring in Great Britain, has sent us their list of publications, consisting principally of handbooks and guides, which will be found useful, not only by the general public, but by those who, in pursuit of botanical, zoölogical, or geological studies, are visiting various places in this country. The usual price of the handbooks is one shilling for cloth books, and sixpence for those with paper covers. The Association, however, publishes more important volumes, such, for instance, as the one on Ightham, the interesting Kentish village associated with Mr. Benjamin Harrison, famous for his work on coliths and other flint implements.

GUNPOWDER AS A WAR REMEDY.—Dr. John H. Clarke, a homoeopathist, has collected together his experiences with regard to gunpowder used more particularly as an internal cure for poisoned wounds. The substance under discussion is, of course, the old-fashioned black powder, and it was used by soldiers long ago. The Indians of North America and Canada have found in it a remedy for snake-bites, while the shepherds of East Anglia use it extensively in treating their flocks and themselves for wounds and blood poisoning of many kinds, and for protecting themselves against wound infection. Dr. Clarke's pamphlet (Homoeopathic Publishing Company, price 6d. net) gives details of cases in which gunpowder has been successfully prescribed.

LECTURES ON PHOTOGRAPHY.—Mr. E. Senior's lectures on Photography at the South-Western Polytechnic Institute, Manresa Road, Chelsea, will begin on Monday, September 27th, at 7.30. There will be twenty-five lectures, fully illustrated by demonstrations and examples of processes. During the first term the course will be of an elementary nature, and suitable for beginners, while more advanced work will be taken later, which will include demonstrations on Autochrome and similar methods of Colour Photography. The lectures will be followed each evening by a practical class, lasting from 8.30 till 10 p.m. At the conclusion of the course there will be six practical demonstrations on Photomicrography. Mr. Senior's lectures at Battersea Polytechnic will begin a day later, namely, on Tuesday, September 28th.

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